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Vol. X. NEW YORK, JULY 16, 1887. No. 3.

THE situation with regard to the manufacture of arc light carbons remains practically unchanged, although one or two recent developments will probably have a marked effect in the long run. Not only has the "pool" formed by the older carbon companies led to the establishment of new manufacturing concerns, and to the endeavor on the part of some of the local lighting companies to make arrangements for co-operative supply, but it has also had as outcome the step taken by one of the largest, most enterprising and influential of the parent companies—the Thomson-Houston—in starting a carbon factory of its own. As announced by our New England representative in his letter this week, the Thomson-Houston Company will have its factory at Fostoria, and will draw on an independent source for raw materials. Some of the other Eastern parent companies have been said, by rumor, to have like projects in view, but the above is the first definite action to record. This movement is most important in its bearing upon what has already taken place. There can be no doubt that the demand from the local Thomson-Houston companies would, by itself, be sufficient to keep a very large factory busy the year around.

WE present in this issue some remarkable figures as to the use of the telephone in four European countries—Belgium, Holland, Italy and Russia. The tables give a list of the exchange subscribers in each county. The total of such is, allowing for a few untabulated exchanges, about 19,000. In other words, in these countries, with a total population of 136,000,000, there are only 19,000 subscribers, all told, or 1 in every 7,158; while in the United States there are 147,000 subscribers in a population of 50,000,000, or 1 in every 340. The disparity is remarkable. There are as many telephone subscribers in New York and Brooklyn as in all Italy with its twenty-eight millions of people; as many in Boston as in Holland with its four millions; more in Chicago than in all the dominions of the Czar.

THE electric motor is already bringing to the poor car horse a welcome surcease from suffering, and thus once again we find electricity enlisted in the work of ameliorating the condition of animals. Some idea of the awful waste of life and energy on a horse-car line in summer may be gained from the figures given elsewhere in our columns as to the Belt Line. The tender-footed green horses put on to replace those killed by the fire have been dying off by the score. On the Broadway road, it appears from statistics recently obtained that the horses only make 9 miles a day and require an hour and forty minutes to do it. On the Eighth avenue road, 12 miles constitutes a day's work for a team. This is not heavy work, but in spite of the care taken by the various companies, the horses even now show signs of pitiable distress far too often, and as the summer advances their physical state is still more sadly reduced.

AN interesting article will be found on another page describing what has been done by Mr. E. H. Johnson, president of the Edison Company, in fitting up his country residence at Greenwich, Conn., with electrical apparatus. The installation is without an exact parallel either at home or abroad, presenting as it does many unique features, especially in the utilization of electric motors and in the arrangements for lighting and heating. In fact, the devices recall by their novelty and originality what was attempted by the celebrated conjurer Houdin, according to the accounts given of his Priory at St. Jervais; and yet there is nothing in the plant that is not within the compass of liberal and judicious outlay, backed by ingenuity. We do not intend to disparage the results achieved when we say that it would be difficult to give a reason why an installation of this kind should not be enjoyed by all possessing the income adequate to maintain such an establishment: and in view of the pleasure and convenience afforded, the expense of the electrical outfit is after all comparatively small. One would not have to go far to find country houses that have cost two or three hundred thousand dollars and that are wanting in every one of the improvements our article enumerates. Now that the example has been set in so spirited and successful a manner, we hope to see other country mansions equipped in this way. Installations of a somewhat similar nature, though far less extensive and striking, are not so very rare in Europe. Thus, in England alone, may be named the plants of Sir David Salomons, Lord Armstrong and the Marquis of Salisbury. The last of these, we believe, comes nearest that at Greenwich in its variety and completeness. It seems to us impossible for any one to visit the house now described without wanting to enjoy its many scientific luxuries, and it is one of the likeliest things in the world that Mr. Johnson may be setting a new and permanent fashion for American millionaires.

WE reproduce on another page a most interesting article by one of our London contemporaries on the present condition of telpherage, as exhibited by the first line built. The Glynde line has now been in operation for about two years. From the showing there made, it is evident that the system is one which is out of the experimental stage and may be counted as one of the practical methods of transportation. The changes which it has been found necessary to make in the method of current transmission are, perhaps, among the most important results attained thus far. Projectors of such lines would naturally be averse to expending money in the equipment of a road the working capacity and durability of which, aside from the electrical question, were dubitable. The various questions seem, however, to have been to a very large extent settled by the present form adopted for the Glynde road, that is to say, it is the method for roads of about the same length and having similar conditions. Though beautiful in conception, the "cross-over parallel system" of distribution by which perfect immunity from accident and collision is insured, necessitated the adoption of steel suspension rods instead of wire rope, and the former were not nearly as durable as had been anticipated. With the substitution of wire rope it became necessary to introduce another system and to fall back upon a simple device, which, while altering somewhat the character of the system, adds to its value in reducing its operation to much simpler elements, and hence must be considered a decided improvement. In the old form, it will be remembered, the suspending rod over which the "skips" or trucks passed constituted both the rail and main conductor for the current. This, of course, necessitated the insulation of the entire line, and, with a conductor-support over an inch in diameter, meant considerable care. The method reverted to is the old device employed in electric railroading of providing a separate independent conductor for the current from the machine, and returning it by means of the rails and earth. This system has now been adopted at Glynde, and the line converted into a simple parallel circuit system, the current being taken off the conductor by a trolley, and, after passing through the motor, led into the suspending wire, which is grounded all along the line, one pole of the dynamo also being grounded. While the power required at Glynde barely reaches 5 h. p. at full load, the work done is nevertheless performed so cheaply that the investment is a paying one. The public was promised some time ago the practical operation of such a road in this country, but although we personally took a trip on an experimental line several months ago, the road is not yet in operation. We are certain, however, that the difficulties standing in the way of a realization of the project are not electrical or mechanical, and that nothing but a practical demonstration is necessary to convince capitalists and others that there is a large field of usefulness for the telpherage system.

THE old idea that "electricity is life" has apparently received a stunning blow in the developments of the last few days. It had heretofore been considered that only lightning and the overhead arc light wire were dealers of death by electricity, but it has remained for a Chambersburg physician to add one more case to prove that electricity is death. Who would have supposed, less than a week ago, that through the agency of electricity one of the greatest boons vouchsafed to suffering humanity during the heated season—ice cream—could be converted into a fell destroyer and the origin of great suffering? Yet such seems to be the case. Having heard of the recent prostration of a number of people through the consumption of ice cream, the physician connected up one terminal of a galvanometer with the copper vessel of the ice cream freezer, and the other terminal with the zinc stirrer, and, behold, various deflections are observed. Electricity in all cases, he finds, dissolves the zinc off the stirrer and saturates the ice cream with zinc salts, and these are the cause of the complaints against the universal refresher. That electricity is present, the galvanometer shows beyond a doubt. The only thing that dims the glory of the investigator, and spoils what might have been a great discovery, is the fact that electricity, though undoubtedly present, is not the cause of the dissolution of the zinc, but the *result* of the dissolution of that metal. In other words, the presence of the electric current is a necessary secondary accompaniment due to the action of the acids or other liquids contained in the ice cream upon the surrounding dissimilar metals. Were but a single metal acted upon, as is often the case in food products preserved in tin cans, the resulting poisonous salts would be present without the accompaniment of the electric current, so that the latter is not to be held as the dangerous element present. Although the Chambersburg physician has thus failed, in our humble opinion, to add to the terrors of electricity, he has nevertheless rendered a great and lasting benefit to mankind in putting us in possession of a sure and easy method of determining the quality of ice cream. It will be noted, in our Philadelphia correspondence, that his experiments extended over a wide range of ingredients or alloys of ice cream, if we may be allowed the expression. Thus, with half cream and half milk, he gets a certain deflection of the instrument. In the same way the various flavors are all definitely indicated and even the baneful corn starch is betrayed with mathematical certainty by the galvanometric reading. Here, then, we have an ingenious method of determining the quality of ice cream, and we are no longer obliged to accept the adulterated article. Each household can supply itself with an ice cream galvanometer, by means of which the quantity of cream, milk, water, flavor, etc., can be read off at a glance. As the instrument would be put in the hands of inexperienced persons, it would, of course, be necessary to make it direct reading, since the amount of time required for calculation with a tangent or other similar type of galvanometer, when no standard cell is present for comparison, would be apt to cause the solid alloy to liquefy. Then again, our manufacturers would do well to devise simple types of the instrument for special purposes. Thus a portable astatic ice cream galvanometer for picnic parties would find a large sale. Other styles will readily suggest themselves to the thoughtful reader, and hence it is not necessary to go further into details. The Pennsylvania physician has thus unconsciously placed in our hands a powerful instrument of analysis, and by continuing his researches he may possibly be able to elaborate a whole system of prompt electrical determination of the adulteration of food products.

The Telephone Statistics of Europe.

We gave a few weeks ago some statistics, compiled by the American Bell Telephone Company, as to the development of the telephone business in this country. Through the courtesy of the Antwerp office of the International Bell Telephone Company, we are now able to present some very interesting figures as to telephonic progress in Europe. The statistics are the latest that have been compiled, and come down to the close of 1886.

The number of subscribers to the following telephone exchanges was:

Belgium.

Brussels	998	Le Louvière	22
Antwerp	1,043	Liége	438
Charleroi	216		
Ghent	419	Total	3,582
Verviers	396		

with an aggregate of about 6,900 kilometres of line wire constructed.

Holland.

Amsterdam	1,263	Arnheim	127
Rotterdam	630	Haarlem	69
The Hague	197	Dordrecht	143
Utrecht	129		
Groningen	65	Total	2,623

Aggregate of line wire about 3,700 kilometres.

Russia.

St. Petersburg	1,080	Odessa	525
Moscow	690	Lodz	209
Warsaw	533		
Riga	403	Total	3,440

Connected on 9,550 kilometres of wire.

Italy.

Milan	1,089	Leghorn	372
Genoa	950	Naples	873
Turin	614	Palermo	478
Venice	216	Catania	215
Rome	2,022	Messina	159
Florence	721		
Bologne	364	Total	8,073

Aggregate of about 12,500 kilometres of line wire.

The largest increase of subscribers was in Belgium, about 18 per cent., and in Russia, about 15 per cent., as compared with the figures of 1885. The other countries show less progress. The average increase of all the said towns which are worked by companies allied with the International Bell Telephone Company, Limited, of New York, is about 10 per cent., against 9 per cent. in 1885, and 9 per cent. in 1884.

In the above mentioned countries, there are besides a certain number of minor telephone exploitations. Thus we find in Belgium 7 small towns with telephone exchanges having a total of about 5'0 subscribers.

In Italy, there may be 12 such small towns with the telephone, about which no reliable data can be obtained.

In Russia, 6 other towns of more or less importance have telephone installations, whose number of subscribers may be put down as 600 in the aggregate, up to the end of 1886.

The McDill Arc Lamp.

In a new arc lamp recently designed by Mr. H. C. McDill, of Fort Worth, Texas, the working parts have been reduced to the least possible elements, and consist merely of a horseshoe magnet and a pair of hinged armatures which, upon being attracted by the magnet, clutch the carbon rod, carry its upward, and thus form the arc.

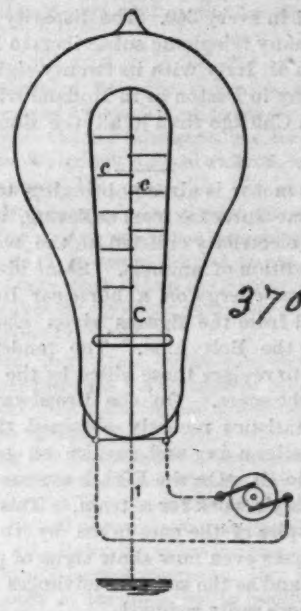
The lamp, which is shown in the accompanying engraving, has the magnets *B B* wound with such a number of ampère turns, that they will just lift the armature, rod and upper carbon, and will hold them in place until the lengthening of the arc has reduced the attractive force to the critical point, when the magnets release the armatures *C C*, which are tripped off the rod by the adjustable sleeve *E*; the rod descends until contact is made with the lower carbon; the current is then reformed, attraction again takes place, and the arc is again established. This action continues as long as the carbons last. This is the theoretical action of the lamp; but in practice it is found that as the carbons burn away, the armature load becomes lighter, the magnets retain it longer, and the arc increases in length. To counteract this, a high resistance magnet *F* is added, which is connected across the arc as a shunt. The core of this magnet is in direct contact with the frame and negative binding post. Below this magnet and supported upon a brass arm is an armature *G*, which is connected with the positive binding post. Below the armature and passing through the brass arm is an adjustable screw *H*, by which the length of the arc is regulated; for, when the arc exceeds the proper length, enough current is shunted around the high resistance magnet to cause it to attract its armature, bringing the positive into contact with the negative pole. This practically short circuits the main magnets and the arc, causing a feed motion of the carbons. It will be observed that the lamp departs from the usual line, in the fact that it is intended as an instant feed lamp. All parts are made light with this object in view. The breaking of the arc, descent of the carbon, and reattraction of the armature clutch are done so rapidly as to make a scarcely perceptible blink in the light.

The remaining new feature of the lamp is the part that does duty for the usual shunt and cut-out. The negative binding post is fastened directly to the frame of the lamp, the positive post being, of course, insulated. Under the positive post, acting as a washer, is placed the shunt cut-out material, which is made of some fusible material having high resistance and of small cost, consisting of a mixture of sulphur and graphite or carbon paper. When from any cause the lamp fails to work, this washer fuses out, allows the positive post to drop upon the lamp and thus establishes a path across for the current. The washer being cheap and the post easy of access, the trouble of replacing it is small.

By the construction of the lamp, the length of the arc is adjustable, and hence its candle power can be varied between 1,000 and 8,000 c. p.

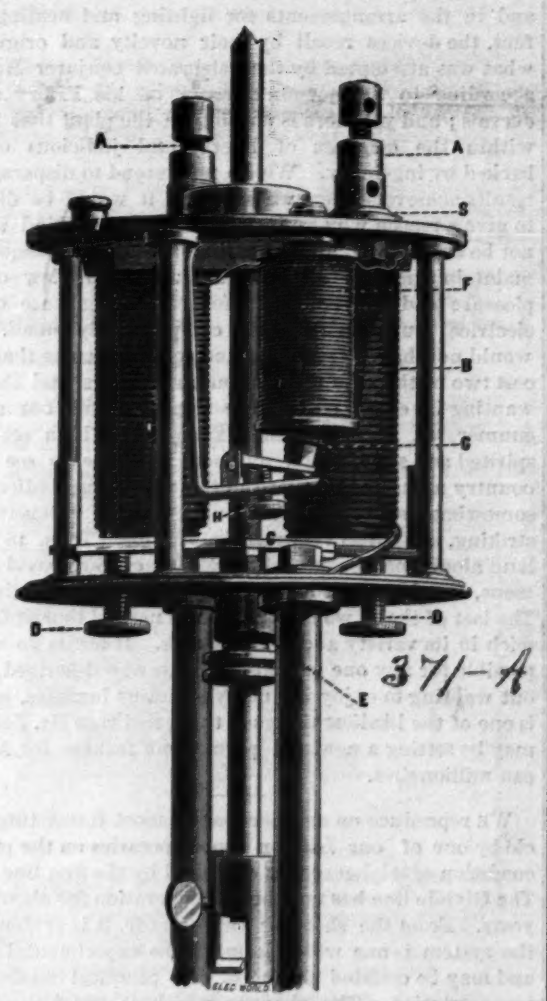
A Novel Method to Prevent the Blackening of Incandescent Lamps.

An incandescent electric lamp while in operation sets free or drives off from its filament more or less carbon in loose particles, which become deposited upon the inner



DEVICE TO PREVENT LAMPS BLACKENING.

surface of the globe and cloud it. Mr. Edward P. Thompson has found that such carbon is, for the most part, set free upon the closing and interrupting of the circuit, and that it is due to the static charge received by the lamp and to the discharge which takes place. In order to avoid



THE MCDILL ARC LAMP.

this injurious action, Mr. Thompson has designed a lamp with means for discharging the high potential currents from the filament and preventing the free carbon from being thrown off, at the same time causing that which is thrown off to be deposited at points where it will not injure the light.

This is accomplished by inserting in the globe an independent conductor which is provided with points projected in opposite directions toward the respective arms of the filament, and connecting the same with the earth.

Referring to the illustration, it will be seen that a conductor *C* extends into the globe between the two arms of the filament. This conductor is provided with sharp points *c c* of conducting material extending in opposite directions toward the respective arms of the filament, but not quite in contact therewith. The high potential currents or charges, especially such as are present upon the interruption of the circuit of the lamp, according to Mr. Thompson, tend to discharge across the arms of the filament to these points, and whatever loose carbon is thrown off at such time will tend to gather upon the inner conductor *C*, rather than upon the surface of the globe. This central conductor is in connection with another conductor, 1, and through the latter the discharge finds a ready path to the earth. Mr. Thompson states it is not always necessary to employ the earth-connection. In some instances it may be found desirable to form the filaments with points projecting toward those of the independent conductor, or the points upon the filaments may be extended into proximity to each other.

The Growth of the American Institute of Electrical Engineers

The American Institute of Electrical Engineers is maintaining a healthy rate of growth, and bids fair to double its membership within the year. At the last meeting of the Council this week, 38 gentlemen were admitted to the Institute from all parts of the country and representing all branches of the profession in its theoretical and practical aspects. The accessions since the end of May are nearly 100, bringing the membership up to about 300. Mr. G. M. Phelps, Jr., chairman of the Committee on Permanent Quarters, reported as to the work done by the committee in connection with the like committee of the American Society of Civil Engineers, and stated that that Society had now started its own fund with the object of securing increased accommodation. The two subscription lists already amount together to nearly $12,000.

The Institute continues to receive pleasant commendations from the scientific and technical press on its work and plans. Many of these we have quoted. Among the most recent is this from the *Mechanical News:*

"Electricity, in its manifold applications, fills a large and increasing space in the chronicles of these times. The science is worthily represented in this country by the American Institute of Electrical Engineers, which was organized in New York a little more than three years since. Its roll of nearly two hundred members, active, honorary and associate, includes most of the famous American electricians now living. The volumes of its transactions, of which three have been published and a fourth is now in press, may be said to cover the entire field of electrical research for the past few years. The society is now contemplating the purchase of a building in this city for its permanent quarters."

Hardening Aluminium Bronze.

To the Editor of The Electrical World:

SIR: Will you kindly answer through your valuable paper how the metal aluminium bronze is hardened? I have had a cutting stamp made of ¼-inch plate, with the word "cancelled" on it, and it is subjected to very rough usage. If you can tell me some way to harden it I will be very thankful. A READER.

NEW YORK.

ANSWER.—There appears to be no way of hardening aluminium bronze except by working it under the hammer, and we presume this would hardly be possible in your case. Heating it and plunging it into cold water will soften it. If you wish to harden the face of the letters a simple and effective way is to plate them electrically with iron or steel. The iron so desposited is very hard. It has the appearance of gray satin when the deposit is a good one. This method is used to harden the face of electrotypes, especially those of maps and drawings in which there are fine sharp lines. When plated in this way they will last much longer and remain sharp and clear; great care should be taken that they do not rust. EDS. E. W.

Best Resistance for Relays.

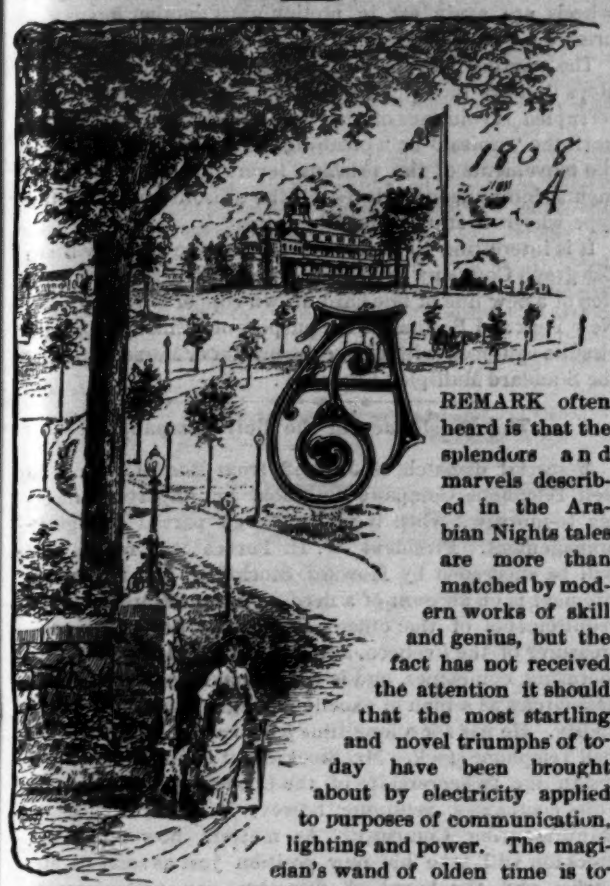
To the Editor of The Electrical World:

SIR: What would be the best resistance for instruments or relays on copper circuits of from five to twenty-five ohms for each circuit? Would I not get less escape and loss of current in wet weather with a low tension current? My idea is that in a low resistance circuit I should use low resistance relays, as, for instance, in district telegraph lines. C. D.

NEW HAVEN, CONN.

ANSWER.—You will obtain the maximum effect in your instruments, whether sounders, relays or any similar receivers, when the resistance of this instrument is equal to the resistance of the rest of the circuit, including battery, line and whatever else there may be. If there are several receivers in series, the sum of their resistances should be made equal to that of the rest of the circuit. The internal resistance of the battery should not be neglected unless it is very low in proportion to the rest of the circuit. As the leakage of the current in wet weather is nothing more than a shunt circuit to the ground through the insulation, it will be less when the electromotive force is less; and as the current in the line must be greater for the same effect when the electromotive force is less, the leakage will be a smaller fraction of the whole. But with low E. M. F. the circuits, if long, will have to be thicker. You are right in saying that in a low resistance circuit the relays should have low resistance, as explained above. A certain authority states that it is not advantageous to use a sounder for a circuit of over 50 miles, but to use a relay instead.—EDS. E. W.

Electricity in the House Beautiful.

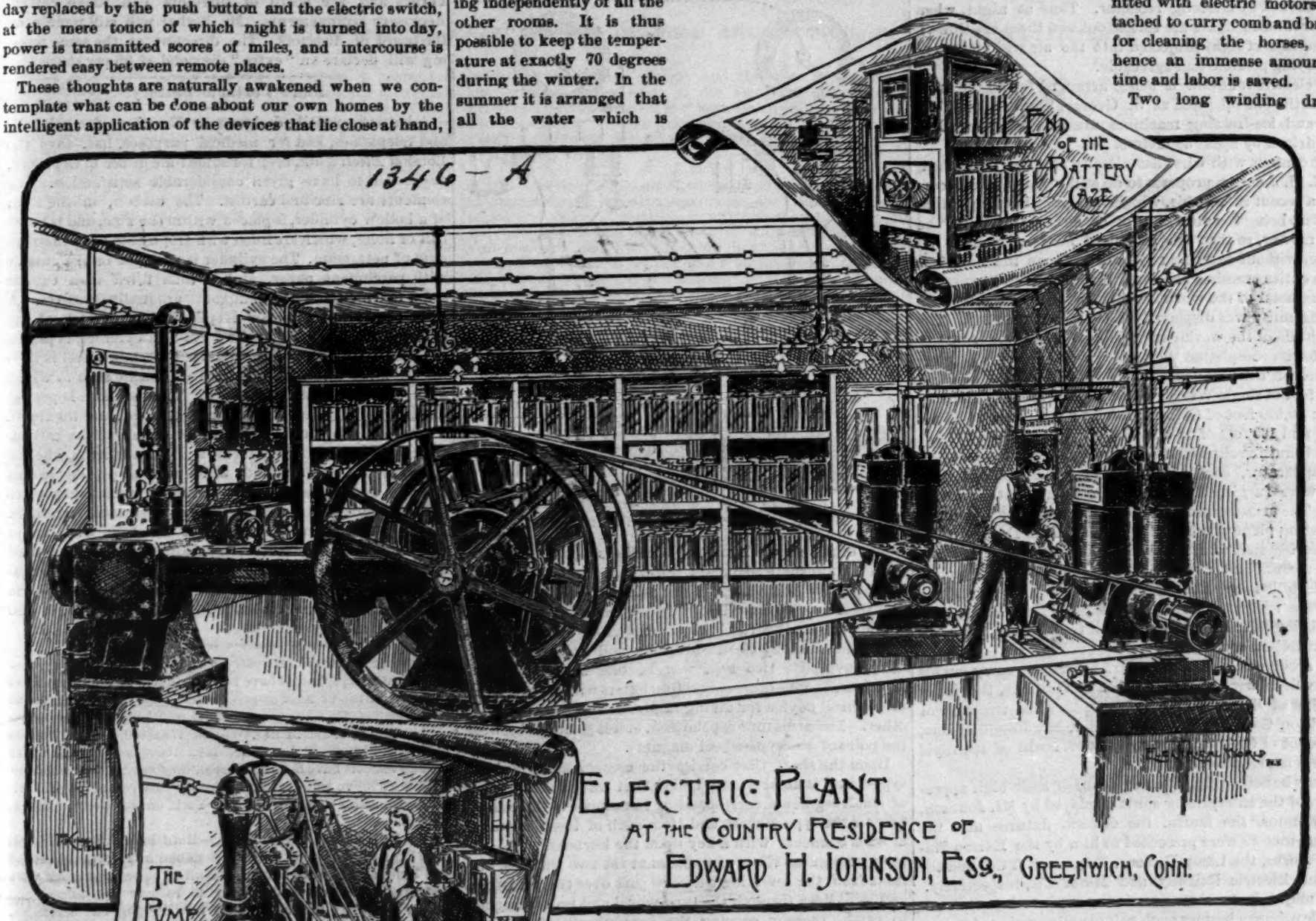


A REMARK often heard is that the splendors and marvels described in the Arabian Nights tales are more than matched by modern works of skill and genius, but the fact has not received the attention it should that the most startling and novel triumphs of today have been brought about by electricity applied to purposes of communication, lighting and power. The magician's wand of olden time is today replaced by the push button and the electric switch, at the mere touch of which night is turned into day, power is transmitted scores of miles, and intercourse is rendered easy between remote places.

These thoughts are naturally awakened when we contemplate what can be done about our own homes by the intelligent application of the devices that lie close at hand, ready for service, and in which the electric current is the prime agent. As an example of the modern use of electricity in domestic employ, the new summer residence of Mr. E. H. Johnson, the president of the Edison Electric Light Company, stands probably without a parallel on this continent. In it, electricity has been put to work of every conceivable nature, and the results obtained must evidently conduce greatly to the comfort and enjoyment of the inmates.

The summer residence of Mr. Johnson is situated on a lofty eminence two and a half miles back from the depot at Greenwich, Conn. It stands in the middle of a lawn of 30 acres, commanding a view of more than fifty miles of Long Island Sound, and is the highest location overlooking the water between Maine and Florida. The house is a large three story structure in the Colonial style, as shown in the little sketch accompanying. It is surrounded by wide porticos which can be illuminated at night with all fancy effects, and is surmounted with a tower which has become a miniature signal service station. At the rear of the mansion is a long row of buildings, commencing with a hard wood finished barn and stalls for fifteen horses, running into a carriage house; a dynamo room, over which are the sleeping apartments for the men; then a boiler room, and ending up with a large bowling alley and billiard room.

The steam plant consists of a 65 h. p. tubular boiler, of the best make, fitted with Jarvis patent furnace, and a new revolving grate bar. The steam piping is fitted up with all the latest improvements, including a grease extractor, and a patent trap for removing the condensed water from the piping. The heating is accomplished by means of a long underground conduit, which, starting out in the open lot back of the boiler room, runs into the cellar of the mansion. Here the conduit ends in a reservoir filled with coils of steam pipe. In winter the air is driven through the conduit and over the coils by means of a Sturtevant blower, operated by an independent Sprague motor, which is situated at the other end. Thus all the air that will be brought to the house is heated before it gets inside the building, and then by a system of independent air passages fitted with electric dampers, which are actuated by thermostats placed in each individual room, the air for each room can be turned off at the entrance of the building independently of all the other rooms. It is thus possible to keep the temperature at exactly 70 degrees during the winter. In the summer it is arranged that all the water which is brought to the place for any purpose passes through the coils situated in this air chamber; cold air is thus forced throughout the house in the same way as the heated air is done in the winter. It is easy therefore to keep the temperature at 75 degrees during the summer months. It is also arranged that either the live steam or exhaust steam can be utilized for heating purposes.



ELECTRIC PLANT
AT THE COUNTRY RESIDENCE OF
EDWARD H. JOHNSON, ESQ., GREENWICH, CONN.

The electric light plant consists of a Straight Line engine 11 × 14, and two No. 10 Ediso dynamos of 200 ampères capacity each. There are also two sets of the Electric Accumulator Company's batteries, of 35 ampères each, making 120 cells in all. The accompanying sketch shows the arrangement of the dynamo room.

By means of a compound switch, seen on the left-hand wall, either dynamo can be thrown on to the battery circuit, or on to the lamp circuit, or all four can be thrown together. In fact any combination of these four circuits can be made by means of this switch. By means of a galvanometer shown in the sketch, called "end of the battery case," the pressures can be so arranged that when they are thrown together there will be no variation in the candle power. The switch shown on the end of battery case allows for the drop of potential in the battery so that the electromotive force can be kept at a certain pressure for the lamps, irrespective of the amount of current which is coming out of the battery.

The pump room shown in the sketch is situated at the side of the dynamo room and contains the pumps which furnish water for the boiler, the house and barn, and all the other arrangements introduced on the premises. Water is obtained from three wells, one of which is 1,200 and another 700 feet from the house. The pumps, located at the spring, were made by the Hartford Air Pump Company. They operate by air, compressed in the pump-room by means of the compressor pumps shown, each of which is fitted with an independent Sprague motor. There are four different pump circuits going to three different tanks in the house, the two largest of which hold 3,500 gallons each, and the smallest of which is in the laundry for domestic use. These are fitted with automatic floats which open and shut the pump motor circuits, and thus start and stop them automatically. There is also a water tell-tale which is run to the engine room, showing the engineer the exact height of the water in the tanks. The engine and pump-room are fitted up in hard wood with fine oil finish, and all the copper is highly polished and lacquered and all the instruments and dynamos are finished in polished mahogany. The floor is laid in hard wood, and handsome chandeliers adorn the walls.

The barn is finished up in the same style, lighted, of course, with incandescent lamps. The cleaning room is fitted with electric motors attached to curry comb and brush for cleaning the horses, and hence an immense amount of time and labor is saved.

Two long winding drives reach the house, lighted on either side, as shown, by slender lamp posts, each surmounted with an Edison lamp. These circuits are controlled independently from the dynamo room. The gate at the main entrance is fitted with a Sprague motor, which can be worked automatically either by the driver, or from the house, and it is arranged so that it will give an alarm at the house whenever the gate is opened. The driveway leads to the house in a large arched entrance, from which hangs a magnificent chandelier. The verandas that extend around the house on both stories are furnished with two circuits, one for lighting purposes, on which each chandelier is represents a piece of large ox-chain, a new and very neat design; while clustered around on all sides are sockets for the insertion of additional lamps for decorative purposes, over 200 of these being on the front of the house.

The main hallway is finished in quartered oak. The ceiling is composed of eight groined arches, each capped with a miniature sun made by Tiffany & Co. Behind these

are Edison lamps, which, reflecting through the different thicknesses of glass, give the well-known outline of a man's face looking from the sun.

The dining room is finished in the same style, with eight handsome chandeliers arranged on different circuits, partially for service and partially for decoration. The parlor is finished in white wood, and the library back of it is finished in rich red cherry.

On the upper floors the rooms are also finished in carved wood of different colors, and the lighting circuits for each floor are brought to a switch-board, which controls that entire floor. There is also a separate independent circuit running through the house called the "pilot light" circuit. This circuit includes one lamp in each room of the house, and can be controlled independently on each floor. At night it can be connected to the burglar alarm, so that, although controllable in other places while the alarm is in its proper position, if the alarm should ring the lights are immediately lighted and cannot be turned off anywhere except at the alarm, which is placed in the proprietor's bedroom. The arrangement is such that the grounds may also be illuminated at the same time.

In a recess in the main hall are arranged a long-distance telephone, and a tele-barometer, tele-thermometer and other registering instruments, furnished by the Telemeter Company, of New York, so that by merely looking at these dials there can be read at a glance the temperature, both indoors and outdoors, the steam pressure on the boilers, the ampères of current flowing out from the different circuits, the velocity of the wind, together with all the other data furnished by a signal service station.

The tennis ground near the mansion is lighted in a novel manner. Here cast-iron boxes, about 6 inches square, are sunk in the earth at short intervals. Each box is covered with plate glass, and within each is an Edison light backed by a strong reflector. Thus at night, when all surrounding lights are turned out and these are thrown on, the rays of light projected into the air will make tennis playing possible and agreeable.

An electric fountain is being arranged for on the same idea as the one operated at St. George, Staten Island, last year, and ice-freezing machines are also being installed, to be driven by Sprague motors.

Not content with what has already been accomplished, Mr. E. H. Johnson proposes to do still more with the current, a recent idea of his, which will probably be put into practice, being the attaching of an electric motor to the lawn mower, so that the attendant need only guide its motion without exerting any pressure upon the machine.

The entire premises are wired for 500 Edison lamps, and the character of the work makes it evident that great care and ingenuity was displayed in their arrangement. The magnitude of the work can be judged when we consider that for its completion there was required over 50,000 feet of wire of the following kinds: 10,000 feet of double and 5,000 feet of single Waring cable; 20,000 feet of Callender cable; 20,000 feet of Grimshaw wire; 3,000 feet of Clark wire; and 100 feet of 20-wire cable.

The beautiful chandeliers and a large part of the accessory apparatus, such as ammeters, voltmeters, switches, etc., were furnished by Messrs. Bergmann & Co., of this city. The arrangement of the motive power and electric generating plant was in charge of Mr. C. L. Edgar, of the engineering staff of the Edison Company.

The steam plant, a model for its purpose, was supplied and installed by Messrs. Potter & Williams, and the elaborate system of wiring by Messrs. Noll Bros., both firms being selected by Mr. Johnson from among the well-known Edison contractors.

The architects employed by Mr. Johnson to carry out his unique ideas were Messrs. Carère & Hastings, the latter a brother of Mr. F. S. Hastings, secretary and treasurer of the Edison Company. To the builder, Mr. Joseph Jeffers, a resident of Greenwich, belongs the credit of the rapid progress made in the construction.

It may be noted that, as an evidence of their high appreciation of the enterprising spirit displayed by Mr. Johnson, the dynamos, the lamps, the electric fixtures and the Sprague motors were presented to him by the Edison Machine Works, the Lamp Factory, Bergmann & Co. and the Sprague Electric Railway and Motor Co., respectively.

We might, in conclusion, note the curious fact that not a single primary battery such as is usually employed in connection with domestic installations—as, for instance, the open circuit batteries for burglar alarm annunciators, etc.—is here to be seen. All the current required is drawn direct from the Edison circuit through the medium of the storage battery.

Brown's Octuplex Printing Telegraph.

Mr. R. G. Brown, the electrician of the Standard Multiplex Telegraph Company, has recently invented a printing instrument adapted to their synchronous telegraph system, by means of which eight messages are simultaneously and independently transmitted over the same wire. The system was put in operation on June 19 last on one of the Postal Telegraph Company's wires between New York and Meadville, Pa., a distance of 509 miles, and gave the most decided satisfaction with printers in circuit.

The printing instrument is extremely simple and can be operated by any one without a previous knowledge of telegraphy, at a speed of fifteen to twenty words per minute for each instrument.

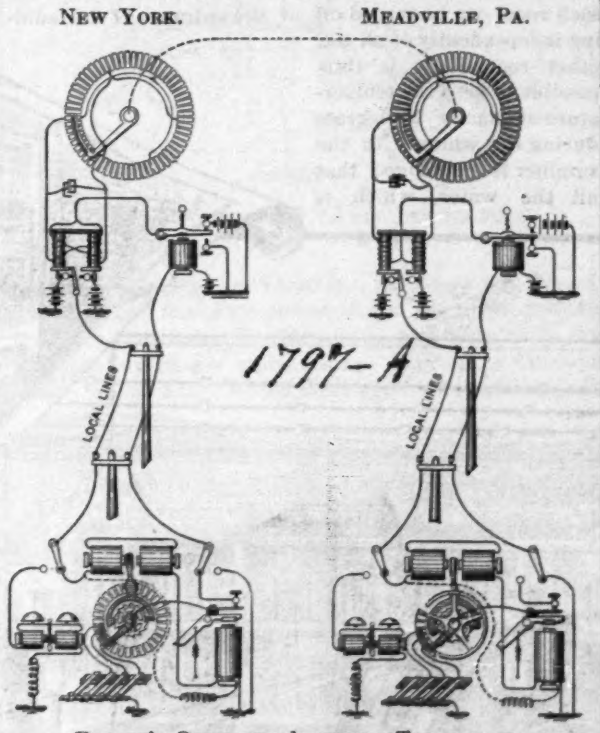
The system is intended to furnish private circuits between distant points, for the use of brokers, bankers, etc., at a lower rental than is now charged for this service.

The accompanying diagram represents the instruments and circuits at the terminals of the main line. In this system, as is well known, revolving arms carrying a trailer rotate with a uniform speed over a circle of segments so that the trailors are simultaneously upon corresponding segments. The line is represented as extending from the shaft of the synchronous instrument located in New York to the shaft of the similar instrument located at Meadville, Pa.

Six segments at equal distances apart are made use of for working each printer.

The relay is connected by two wires with these six segments in the manner shown, three segments being connected to one wire and three segments with the other wire. The wires after passing through the relay are connected to the armature of the transmitter, the top stop of which is connected to the main battery and the lower stop to earth.

The armature of the transmitter at the New York station is against its battery contact, while the similar armature at the distant station is to ground, representing New York transmitting to Meadville. Hence, as the trailers of the synchronous instruments come in contact with one of their segments, the current of the main battery at New York passes through the polarized relays in one direction, causing their armature to be brought in contact with one of their stops; and when the trailers reach the next segment the direction of current through the relay is reversed, and the armatures swing simultaneously into contact with their other stop. Thus, as the trailers come in contact with the alternate segments, the direction of the current through the relays, and their polarity, will be reversed, and their armatures will vibrate between the two stops.



BROWN'S OCTUPLEX PRINTING TELEGRAPH.

The printing instruments are actuated by clockwork, and controlled by electro-magnets and reverse currents. They have each two type wheels, one with figures and fractions, and the other containing letters with an automatic mechanical device for taking impressions from one or the other. The armature is polarized, and is pulsated between the poles of the type-wheel magnets.

Upon the shaft that carries the escapement-wheel and type-wheel is an arm and trailer that travels over a circle of small segments, corresponding in number to the characters on the type-wheels, and from each of these segments a wire connects with a key upon the keyboard. As the relay armatures vibrate in unison at the two stations, currents from the reversing batteries pass over the armatures and local lines through the type-wheel and press magnets to earth, thereby causing the type-wheels of the two printers to revolve in unison. But these reversals of current through the press magnet are too rapid to cause it to actuate its armature, because the latter is adjusted and the magnet constructed to act sluggishly.

If, now, the operator at the sounding station depresses one of his keys, a circuit is closed from the ground through the key, its segment, and through the trailer of the printer (when it arrives on that segment), over the local line to the transmitter and to earth, causing the transmitter lever to be drawn away from its top stop and thereby taking the main battery off the line. The relay armatures then cease to vibrate, the type-wheels stand still and the prolongation of contact of the relay armatures with the reversing batteries sufficiently charges the press-magnets to actuate their armatures and take the desired impression from the type-wheels. The transmitter circuit is broken by the downward movement of the press armature at the insulated spring that it carries; hence the transmitter lever instantly flies up, again connects the main battery to the main line, and the pulsations in the relays are re-established simultaneously; so that the type-wheels are again set in motion until another key is depressed.

The printing instruments are each provided with unison stops that are brought into action by about three uninterrupted revolutions of the type-wheels, and continue so until the "unison" or "breaking" key is depressed, when the movements of the printing levers at the two instruments simultaneously throw off the unisons and allow the type-wheels to start off together.

It is interesting to note that the Empire and Bay State Telegraph Company have almost completed the construction of a new line of fine hard-drawn copper wires between New York and Boston for the purpose of furnishing private circuits equipped with either the printer or Morse system of the Standard Multiplex Company.

The Presidency of the Bell Company.

A special dispatch of July 12 from Boston says: The Bell Telephone Company will hold an important meeting to-morrow, when it will undergo partial change in management. President W. H. Forbes will resign, and will be succeeded by Howard Stockton. Mr. Forbes' retirement is on account of a need of more leisure than the requirements of the office afford. Mr. Stockton is the treasurer of the Cocheco, Salmon Falls and Essex Manufacturing companies, and is well known in Boston business circles as a man of excellent judgment and executive ability. He has for a long time past been a large holder of Bell Telephone stock. Mr. Stockton, it is understood, will resign the treasurerships of the Cocheco and the Salmon Falls companies, retaining, however, that of the Essex Manufacturing Company. As matters now stand Mr. Stockton will take his new position just as soon as Mr. Forbes and the board of directors can make certain necessary arrangements. Mr. Forbes will still remain on the board of directors. The directors at the same meeting will declare an "extra" dividend of $6 per share.

Dun's Portable Battery.

A battery specially designed by Herr Dun for call bells and telephones, and for medical purposes, has, says the London *Electrician*, been for some time in use in Germany, and is said to have given considerable satisfaction. The elements are zinc and carbon. The carbon, in the form of a hollow cylinder, is placed within the zinc, and is bored full of holes, which are filled with fragments of permanganate of potassium. The cylinder is wrapped on the outside with parchment paper, and is then filled with caustic soda, in which the permanganate gradually dissolves. A piece of parchment paper is placed over the top of the cylinder, the zinc (also in the form of a cylinder) is placed in position outside, and the glass or porcelain vessel is then nearly filled with a hot solution of caustic soda to which a little starch has been added. This solution is poured until both cylinders are entirely covered, and the liquid stands an inch or so above the upper surface of the carbon. On cooling, the solution forms a gelatinous mass, like the "graphs" of various kinds which were so popular in this country a few years ago. Insulated conducting wires are, of course, led from the plates to suitable terminals. Finally, the outer vessel is filled to the brim with plaster of paris, or, if preferred, with paraffine, which is poured on top of the starch jelly. By this means the permanganate solution is thoroughly protected from atmospheric action. The internal resistance is said to be low, so also is the cost of the cell.

Storage Batteries for Street Cars.—For the past three or four months experiments have been going on in Philadelphia to demonstrate the value of storage batteries for furnishing power for propelling street cars. President C. A. Richards, of the Metropolitan Railroad, and Messrs. William Wharton, Jr., and Thomas Cochrane, of Philadelphia, have been the agents through whom the experiments have been conducted, they having purchased last fall the exclusive right to use the storage batteries of the Electrical Accumulator Company, of New York, on street cars.—*Boston Herald.*

The Belt Road, New York.—Hard luck pursues the Belt Line Horsecar Company. Since its stables at Fifty-fourth street and Tenth avenue were burned, and all its horses and stock were destroyed, it has been endeavoring to recover its business and former prosperity under the most discouraging circumstances. At present it has sufficient "bobtail" cars to accommodate the most of its traffic on the First avenue and Fifty-ninth street branch road, but the route to be covered, which extends all around the city from the Battery to Central Park and along the East and North River fronts, is furnished with only fourteen old-time dingy and "stuffy" cars. To keep these conveyances on any sort of schedule time, it has become necessary to retain five different relays of horses to work on both halves of the ful route or circuit. The fire necessited the purchase of 700 new or "green" horses. The torrid weather that has prevailed lately has had fearful effect upon those inexperienced animals. After dragging the heavily-loaded cars in the broiling sun all day the horses have become so jaded and worn out at night that they have been dropping dead in their stalls at the rate of from two to five at a time. Out of the seven hundred head purchased by the car company but about four hundred remain. The stockholders and directors of the company are now considering the advisability of adopting some other mode of locomotion than animal power. The charter of the company permits this alteration. Some electric motor will probably be adopted. It is thought that by the use of some other than horse power less blockading would be caused, traffic would be made more expeditious and secure, and the road would be operated at a far less expense.—*New York World.*

Modes of Measuring the Coefficients of Self and Mutual Induction.*

BY PROFS. W. E. AYRTON AND JOHN PERRY.

The following method and instruments have been devised for determining in an accurate and practical way a measure of self and mutual induction.

The instruments employed have, in various forms, been in use some time, but a complete description of the principles involved has only recently been vouchsafed by the inventors, who have been making changes in the construction of the instruments as practical defects were discovered.

The method employed embodies the application of a Wheatstone bridge with particular means for making and breaking the battery circuit, and short circuit tor the galvanometer.

A circuit containing self-induction acts as if it had a larger resistance than its true one when a current is started in it, and a smaller resistance when the current is stopped. Hence, if balance be obtained with a Wheatstone bridge in the ordinary way, the fact of any of the arms possessing self-induction, or of any of the arms having a condenser attached to it, will produce no effect on the balance if the battery circuit be rapidly made and broken, provided that the rapidity of make and break be not too great for the currents in the arms of the bridge to reach their steady values each time that the battery circuit is made, and to die away each time that it is broken. If the currents have not time to reach their steady value when the battery circuit is closed, and to die away when it is broken, then self-induction in any one of the arms will produce a disturbance in the balance; but such a method of measuring a coefficient of self-induction would lead to very complicated formulæ, and is not worth developing with the view of obtaining a simple method of measuring self-induction.

It therefore occurred to Profs. Ayrton and Perry, to consider whether, without employing such rapid makes and breaks as would prevent the currents reaching their steady values, the self induction of a circuit might not be made to act as an apparent steady definite increase of the resistance of that circuit which could be measured in the ordinary way with a Wheatstone bridge or differential galvanometer, and by this means the measurement of a coefficient of self-induction would simply resolve itself into the measurement of a resistance. This problem was solved in the following way, in the spring of 1886:

The coil, the coefficient of self-induction of which it is desired to measure, is placed in one of the arms of a Wheatstone bridge, the three other arms consisting of ordinary doubly-wound resistance coils possessing no appreciable self-induction, and not only is the battery circuit rapidly made and broken, but, in addition, after each closing of the battery circuit the galvanometer circuit of the bridge is either short-circuited or broken so as to cut out the galvanometer, and after each breaking of the battery circuit the galvanometer circuit is either unshort-circuited or closed again, so that the galvanometer is now operative again. In this way all the successive impulses of the galvanometer needle that are produced on starting the current in the coil with self-induction produce their *cumulative* effects, but the successive impulses of the needle, that, under ordinary circumstances, would be produced on the needle in the opposite direction are cut out Hence the self-induction possessed by one of the arms causes that arm to apparently increase in resistance by a definite amount depending on the coefficient of self-induction and the number of operations performed per minute. This apparent increase of resistance produces a deflection of the galvanometer which can be noted, and its value ascertained by comparing it with the deflection produced with steady currents when one or more of the arms of the bridge is altered by a known amount. But since the necessity of having to read the deflection limits the speed of performing the double make and break operation, in order that the spot of light may not be sent off the scale, this comparative deflection *cumulative* method was soon replaced by a much more sensitive *zero cumulative* method, and instead of reading the galvanometer deflection they re-establish the balance and bring the needle back to zero, by altering one or more of the arms of the bridge, as in making an ordinary resistance test with a Wheatstone bridge.

In their experiments they have also preferred the periodical short-circuiting of the galvanometer to breaking the galvanometer circuits, since, as there is a current flowing in the galvanometer when this operation is performed if the zero method be employed, the breaking of the galvanometer circuits would produce a spark which would make the calculations difficult, whereas, as will be seen, the periodical short-circuiting of the galvanometer produces an effect that can easily be taken into account in the mathematical investigation.

The measurement of a coefficient of self-induction in this way is extremely simple, because on the condition that the periodic time of the operation is not too short for the currents to become steady in the interval between the closing of the battery circuit and the short-circuiting of the galvanometer, and to die away in the interval between the breaking of the battery circuit and the unshort-circuiting of the galvanometer, they have shown that the following *remarkably simple* formula is very approximately true:

$$L = T\sigma \qquad (1)$$

where L is the coefficient of the self-induction of the coil in ohm seconds, or earth quadrants, the commercial unit of self-induction, T the time in any one operation that the galvanometer is non short-circuited while the battery circuit is closed, and σ the apparent increase of resistance of the coil in ohms. It will be observed that when L is small the measured increase of resistance, σ, may be made quite large enough to be accurately measured by making T small. This may be done either by performing the operation rapidly, or, as will be seen later on, by altering the adjustment in the particular apparatus which automatically performs the required operation. *Hence this method is an extremely delicate one for the absolute measurement of a coefficient of self-induction and the coefficient is expressed in its simplest possible form, namely, as the product of a time into a resistance.*

If, instead of periodically cutting out the galvanometer circuit while the battery circuit is being broken, it is cut out while the battery current is being made, and the galvanometer allowed to be operative while the battery circuit is being broken, the resistance of the coil possessing self-induction will apparently become less by a definite amount, and in this case σ will be the apparent diminution of its resistance, and T is the time the galvanometer is operative after the battery circuit is broken.

The first apparatus for enabling measurements of self-induction to be made in this way was constructed in the spring of 1886. It consisted of a double commutator, shown in Fig. 1, the spindle S, to which the commutators were locked by the nut N, being rotated at any speed by a small electro-motor, not shown in the figure, to which was attached a Young speed indicator, which registered the speed of rotation at any moment. The brushes B_1, B_2, b_1, b_2 were fixed to the baseboard and joined to the bridge, as indicated in the figure. When the double commutator was rotated by the motor (of which the speed was correctly adjusted by means of a Varley flexible carbon-resistance), the portion $A\,B$ caused the battery circuits to be periodically made and broken, while the other portion $C\,D$ periodically short-circuited and unshort-circuited the galvanometer, so that the following cycle of operation, called for simplicity *one operation*, was performed any desired number of times per minute.

Battery Circuit.	Galvanometer Short Circuit.
Make.	While broken.
While made.	Make.
Break.	While made.
While broken.	Break.
Make.	While broken.

The time T in the formula given above is the interval that elapses in one rotation between the time when the continuous part of the commutator $A\,B$ comes into contact with the brush B_2, and the time when the continuous part of the commutator $C\,D$ comes into contact with the brush b_2. This time can be made shorter or longer by varying the speed of rotation, but it can also be varied by loosening the nut N, and shifting one of the commutators round relatively to the other, and then screwing up the nut again.

A determination of the formula which expresses these principles is in part given as follows:

Fig. 2 shows the Wheastone bridge, s being the resistance of a coil with a coefficient of self-induction L; p, q and r are the resistances of the three other arms of the bridge when they are so adjusted that there is no deflection of the galvanometer on rotating the commutators at a certain speed. On rotating the commutators a current will sometimes pass one way through the galvanometer and sometimes the other, but with the particular speed of rotation p, q and r are such that the total quantity passing through the galvanometer is nought. The resistance and coefficient of self-induction of the galvanometer are g and λ, and the electromotive force and resistance of the battery E and b. Then if x, y, z be the imaginary currents on the meshes,*

$$r(x-y) + p(x+z) + gz + \lambda\frac{dx}{dt} = 0$$

$$b(y+z) + r(y-x) + sy + L\frac{dy}{dt} = E.$$

$$b(y+z) + px + qz = E.$$

Eliminating y and z, we have

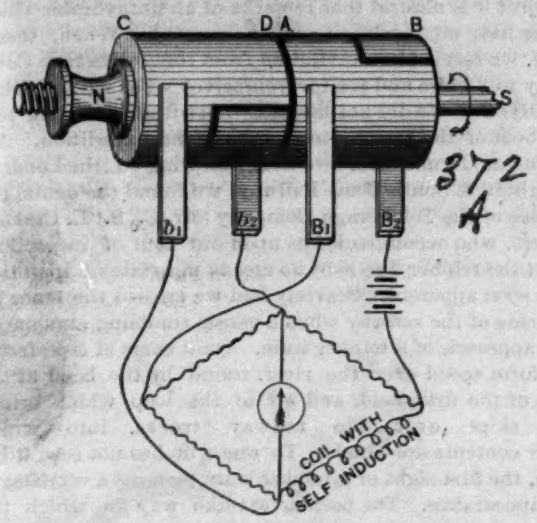
$$Ax + B\frac{dx}{dt} + P\frac{d^2x}{dt^2} + C = 0$$

where
$$A = \begin{vmatrix} r+q+g & -r & q \\ -r & s+b+r & b \\ p & b & p+q+b \end{vmatrix}$$

$$B = \lambda\begin{vmatrix} s+b+r & b \\ b & p+q+b \end{vmatrix} + L\begin{vmatrix} p+g+r & p \\ p & p+q+b \end{vmatrix}$$

$$P = (p+q+b)\,L\,\lambda,$$

$$C = E(ps - qr).$$



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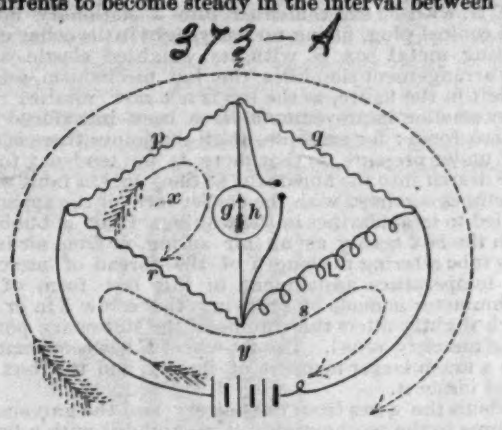

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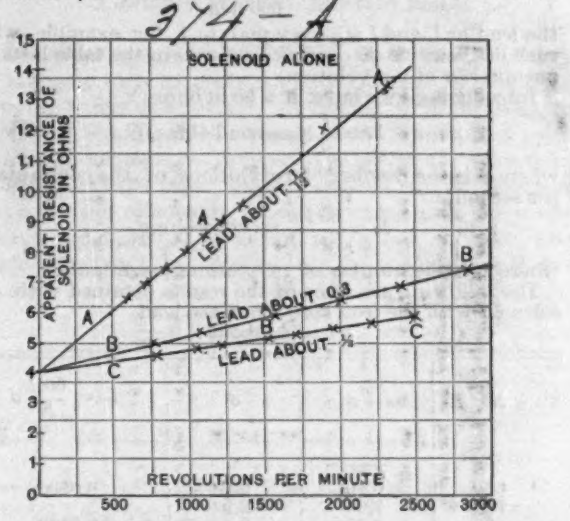
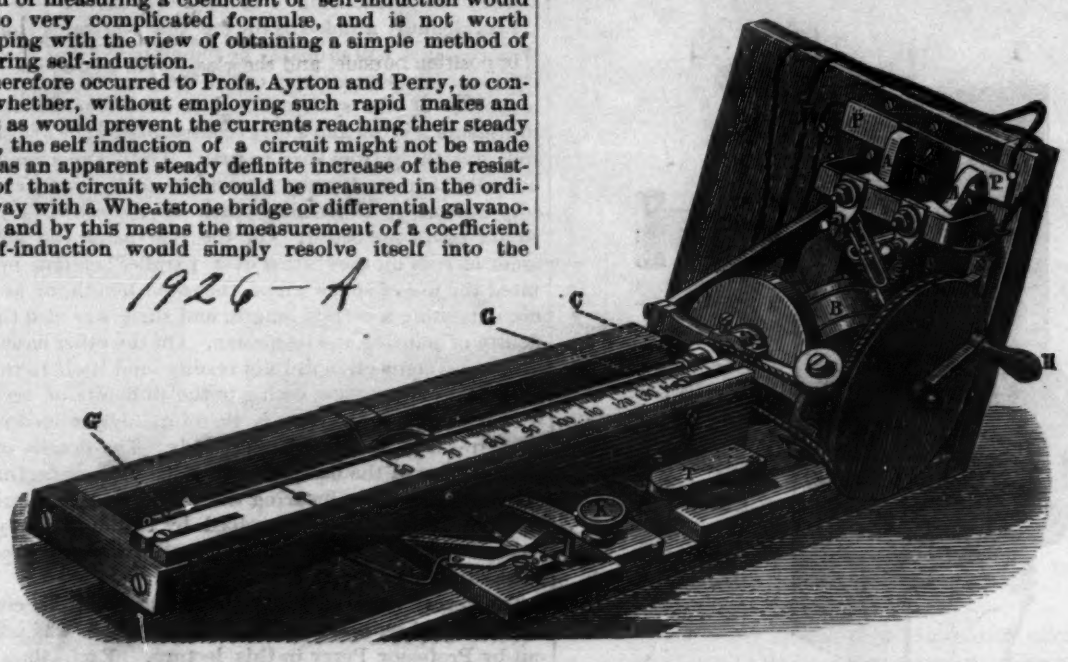


FIGS. 1, 2 AND 3.—MEASUREMENT OF SELF AND MUTUAL INDUCTION COEFFICIENTS.



FIGS. 4 AND 5.—AYRTON & PERRY SECOHMMETER.

*Abstract of a paper read before the Society of Telegraph Engineers and Electricians.

*For the method of solving such problems by the employment of these imaginary currents, see a most interesting paper by Dr. Fleming, in the *Proceedings* of the Physical Society, Vol. VII., p. 215.

From these equations it is shown that

$$L = \sigma\left(T + \frac{\lambda}{g} - \frac{B}{A}\right)$$

and that $\frac{\lambda}{g}$ and $\frac{B}{A}$ are usually small compared with T; therefore when this is the case,

$$L = \sigma T,$$

the simple formula previously referred to.

Referring to Fig. 1, it will be seen if the brushes B_1 and b_1 touch over a small area, and if the centres of these areas are in a plane passing through the axis of rotation, that T is simply equal to

$$\frac{\text{angle between the slits in the two commutators}}{360 \times \text{number of revolutions per second}}.$$

We may call

$$\frac{\text{angle between the slits in the two commutators}}{360 \text{ deg.}}$$

the lead or l, and l will be equal to $\frac{1}{4}$, for example, when each of the cycle of operations given in the table lasts for one-quarter of a revolution.

Introducing l we have, if σ be in ohms,

$$L = \frac{l}{n}\,\sigma \text{ second-ohms},$$

where n is the number of revolutions of the commutator per second, or

$$L = \frac{60\,l\,\sigma}{N} \text{ second-ohms}$$

where N is the number of revolutions per minute.

The following are some of the results obtained with the solenoid with the iron core when the lead $l = \frac{1}{12}$ about:

N	$s+\sigma$	σ	$L = \frac{60\,l}{N}\sigma$
0	4.06		
660	6.70	2.64	0.0200
760	7.00	2.94	
860	7.50	3.44	0.0200
997	8.00	3.94	
1117	8.50	4.44	
1240	9·00	4.94	
1362	9.50	5.44	0.0200
1450	11.00	6.94	
1850	12.00	7.94	0.0204
2335	13.50	9.44	0.0202

Plotting these results on squared paper, we obtain the curve AAA (Fig. 3), the abscissæ representing the values of N, the number of revolutions per minute, and the ordinates the value of $s + \sigma$, the apparent resistances of the solenoid at the various speeds. This curve we see is a perfectly straight line, which means that the increase of resistance is proportional to the speed; or, in other words, the approximate formula for calculating L may be employed with *any* of the results, and the value of L so obtained from a few of the results is given in the last column of the preceding table. That we may use the approximate formula at all for L shows us that the term

$$\frac{\lambda}{g} - \frac{B}{A}$$

in the true expression is negligible in comparison with T; and that we may use it even for the result obtained with the highest speed of rotation employed, viz., 2,335 revolutions per minute, shows us that $\frac{1}{12 \times 2335}$ minute, or about 0.0022 of a second, which is the time the galvanometer remains unshort-circuited after the battery circuit is closed, is long enough for the currents in the bridge to reach their steady value.

Continuing the above experiments with the same solenoid after introducing an iron core, and plotting the results, it was found that the great difference between the curvature of the lines for a range of even slow speeds when the iron core is introduced, and the perfect straightness of the lines beyond the highest speed, 2,800 revolutions per minute, employed with the solenoid alone, arises from the coefficient of self-induction of the solenoid, with the iron core inserted, being about twenty-five times as great as the self-induction of the solenoid alone. Hence the smallest interval, T, between the closing of the battery circuit and the short-circuiting of the galvanometer that can be employed is much larger when the iron core is inserted than when the solenoid alone is used. Consequently, in this case, the lead must be large or the speed must be slow for the results to lie in a straight line.

Figs. 4 and 5 show the experimental and commercial forms of the secohmmeter. The first, being given as its parts, are somewhat clearer shown than those of the latter. The letters referring to the illustrations are the same in each case.

It will be observed that these instruments are in reality an ingenious combination of the commutator, already described, and a method for driving the same and a speed indicator to give accurately the velocity of the commutator when an observation is made.

Attached to the commutator of the self-induction apparatus is a box B, Fig. 4, fitted with weighted elastic sides made of corrugated steel, which fly out more and more under the action of centrifugal force, as the box is rotated faster and faster. A stout glass tube G, of comparatively small bore, open at both ends, is cemented into a collar in the axis of the box, and rotates with the box. The box is completely filled with mercury, and the tube partially, hence the volume of the box expands as its sides fly out, and the length of the column of mercury in the tube diminishes so that the length of the column at any moment is a measure of the speed of rotation of the box. In the neck of the collar C, in which the tube is cemented, there is a steel tap attached to an axial spindle passing through a tube inside the box, and projected out of this tube at the other end of the box. If this spindle be turned relatively to the box, the tap is opened or closed. At the commencement of an experiment the tap is opened, and the handle H is turned with the right hand, faster and faster, until, on depressing the key K with the left hand from time to time, the galvanometer needle is seen to be approaching zero, or the spot of light to the zero position on the scale. The key may now be kept depressed, and on turning the handle a little faster a speed is at length reached producing exact balance. At this moment the trigger T is lightly touched with the left hand and a spring is liberated. This has the effect of producing a resistance to the rotation of the tap spindle, which previously was rotating freely with the rotating box, and the tap is thus turned off, cutting off the connection between the mercury in the glass tube and that in the box. Consequently the mercury in the tube remains, even after the instrument is stopped, of exactly the same length that it had when the trigger was touched. *The position of the end of the thread of mercury in the tube is now read off on the scale attached, and the apparent increase of resistance of the coil, electro-magnet, or whatever it may be, divided by the number on the scale, gives the required co-efficient of self-induction in second-ohms without any further calculation.*

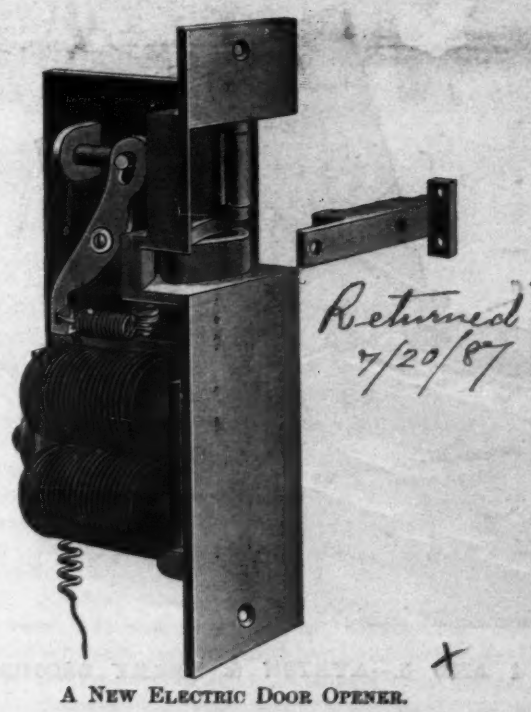
The instrument is therefore *direct reading*.

Unless the glass tube in the secohmmeter be rather long, either the sensibility or the range of the instrument must be limited; but a very long straight tube would make the instrument inconveniently large, and a rapidly rotating *spiral* tube would probably break from centrifugal force acting on these parts of the tube that were not on the axis of rotation. Hence, in the latest form of secohmmeter, Fig. 5, there is employed a *stationary* spiral glass tube G, with its end cemented into a stationary hollow steel conical plug, fitting mercury-tight in the collar of the rotating metal box B, with its weighted elastic sides. This arrangement simplifies the tap mechanism, seen to the left in the figure, as the tap is not now rotating; also many smaller improvements have been introduced into this last form; for example, at all the joints there is mercury under pressure, so that there is no tendency for air to be drawn into the apparatus at the joints, a fault which sometimes occurred with the earlier form of the apparatus and led to irregularities in the readings from a bubble of air in the box acting as an air spring, or from air in the glass tube altering the length of the thread of mercury. The temperature adjustment in this last form of the secohmmeter is made by screwing the screw S in or out, which slightly alters the volume of the stationary portion of the mercury vessel. The fly-wheel F has been made to have a much larger moment of inertia, and the box B is placed inside it.

As both the wires from the battery and the galvanometer come to the secohmmeter, it is provided with a bridge key, so that the test of the ordinary resistance of the coil, electro-magnet, etc., can be made by using the same key as is used in putting on the battery when the self-induction experiment is being made. When the bridge key is being used in the ordinary way to first close the battery and then the galvanometer circuit, it is obviously necessary that the battery circuit should not be permanently broken nor the galvanometer short-circuited at the commutators of the secohmmeter, which may by chance have been left after the last experiment in a position which does one or both of these things.

An Electric Door Opener.

In apartment houses it is a great convenience, in fact, almost a necessity, to have some appliance by means of which persons residing on the upper floors can open the



A NEW ELECTRIC DOOR OPENER.

front door without descending the stairs. In order to meet the necessities of the case, Messrs. E. A. Wildt & Co., of this city, have recently designed the electric door-opener shown in the accompanying cut. It consists essentially of two parts, one electrical, the other mechanical. The electrical part is composed of two electro-magnets which attract an armature, thereby releasing a catch and unlatching the door and at the same time pushing the latter open.

The principal features of the mechanism are two springs, one of which is in direct tension when the door is closed, and the other in spiral tension. When the armature is attracted by the magnets, thus releasing a catch, the tension on the springs is removed. The direct tension spring on being released throws the latch back by means of a lever and the other spring forces the door open. The apparatus is simple in construction and can be easily put in place.

By connecting the electro-magnets with a battery and a push button situated on each floor, the door may be opened by the mere touch of the button.

Killed by a Pole.—Last week a telegraph pole, said to be rotten, at Fifty-fifth street and Tenth avenue, fell without warning and crushed a boy to death.

The Telpher Line at Glynde.*

The telpher line at Glynde has now been in operation for a period of over two years, and the time has certainly arrived when the question as to the success or non-success of this system of transport should receive a final answer. The question is admittedly one of no slight importance. If telpherage can be demonstrated to be both technically and commercially practicable under the conditions of everyday service, it is not too much to assert that "the resources of civilization" will have been appreciably widened, while the electrical industries will be materially benefited to an extent which no one can at present foresee.

But is the Glynde line a success? So little definite information having appeared in the public prints on the subject it is natural that remarks of an unfavorable character have not been altogether wanting. When, therefore, we received an invitation from the Telpherage Company to "come and see for yourselves what we are doing at Glynde," we did not hesitate—notwithstanding the torrid heat of the season—to undertake the expedition. Arriving at Glynde after two hours' stewing on the London, Brighton & South Coast Railway, we found the genial engineer of the Telpherage Company (Mr. C. S. E. Crakanthorp), who accompanied us upon our tour of inspection. That the telpher line is by no means in a state of inanition was soon apparent. Scarcely had we crossed the fence by the side of the railway when a gentle rumbling announced the approach of a telpher train. On it came at a perfectly uniform speed over the river, round by the bend at the end of the first field, and on to the loop which brings the skips over the railway trucks, into which their contents are tilted. To one who has not seen it before, the first sight of a telpher train presents a very singular appearance. The pecular cat-like way in which the skip in front climbs over the top of the poles and walks steadily over the inclines, while the wire rope sags beneath the weight of the train, is very striking. What is actually being done at Glynde may be summarized as follows: Three trains are running continuously, each consisting of ten skips, and making on the average about 15 journeys daily. Each train carries rather over one ton of clay, so that the total weight moved is about 270 tons per week. The engine plant and the capacity of the line itself are equal to a service of four trains, so that 360 tons per week could be carried with very little increase on the present working cost. That cost is at present £6 per week, a figure which enables the Telpherage Company to carry out their contract with the Sussex Portland Cement Company, of Newhaven, under remunerative conditions, even at the low contract rate of 7½d. per ton.

I incidentally alluded to the fact that the trains run upon wire ropes; it will probably be remembered that the original plans (or more strictly *one* of the original plans) of the inventors of the system, the late Professor Jenkin and Professors Ayrton and Perry) contemplated the use of steel rods stretching from span to span. Until experiment had actually been made upon a working scale it was confessedly difficult to determine which of these two methods would prove the better. On the one hand the employment of rods on the "cross over parallel" system necessitated the use of spans all of the same length, or at least not exceeding a certain length, and there was also the difficulty of jointing and insulation. On the other hand, that system of connection did not readily lend itself to the employment of wire rope, owing to the difficulty of securing it to the post-heads. It was therefore determined in the first instance to employ steel rods. The details of the construction of the line, together with the wonderfully ingenious devices for insuring the safety and regularity of the service, were fully described by Professor Perry in a lecture delivered at the London Institution, and reported at the time.

The "cross over parallel" system, beautiful in conception as it is, has, however, one defect, which was pointed out by Professor Perry in this lecture. Each time that the collecting wheels of the motor passed from one conductor to the other—that is to say at every post—the current through the motor is reversed, a reversal which necessarily entails sparking at the brushes. It remained to be seen how far this drawback would in practice counterbalance the advantages of the system in the matter of economy arising from the fact that only two (intercrossed) conductors are required for both up and down lines.

After some experience, it became apparent that the motors at first adopted were unsuited to this particular class of work under the then existing conditions, and it unfortunately happened that the gentleman by whom the motors were originally designed was unable at the time to give his personal attention to the matter. We think it right to mention this fact because we are anxious not to give an unnecessarily unfavorable impression as to the merits of this particular motor, which, as Mr. Crakanthorp was himself careful to point out to us, has scarcely been able under the circumstances to receive a fair trial.

At this junction, however, an Immisch motor was placed upon the line in parallel with one of the older type, and it at once became apparent that the former did the same work with exactly one-half the energy supplied—

* London *Electrician*, June 17.

that is, one-half the number of ampères at the same volts. It is not, therefore, surprising that the Immisch motor has been finally adopted by the Telpherage Company. The type at present in use has a 4-inch armature, weighs 105 pounds, and develops 1 horse-power running at 1,700 revolutions.

Concurrently with the change of motors it was decided to make such alterations to the line itself as would allow a simple parallel system to be adopted, principally in order that steel wire ropes might be substituted for rods, which were found to have a very much shorter life than had been anticipated. This has been carried out with great success; the steel ropes are 2¼ in. in circumference, and are anchored to cross-beams buried in the soil, with tightening screws for straining up when required. The alteration necessitated, however, the employment of a second wire on both up and down lines in order to convey the current. This wire, which also takes the form of a steel wire rope of 1¼ in. circumference, is insulated throughout its length. The current is taken off by a jockey pulley made in copper with wide flanges, and the wire upon which the train runs is earthed throughout, as also is the negative terminal of the dynamo. The system, in fact, has now reverted very nearly to that described in one of the earlier patents of Profs. Ayrton and Perry.

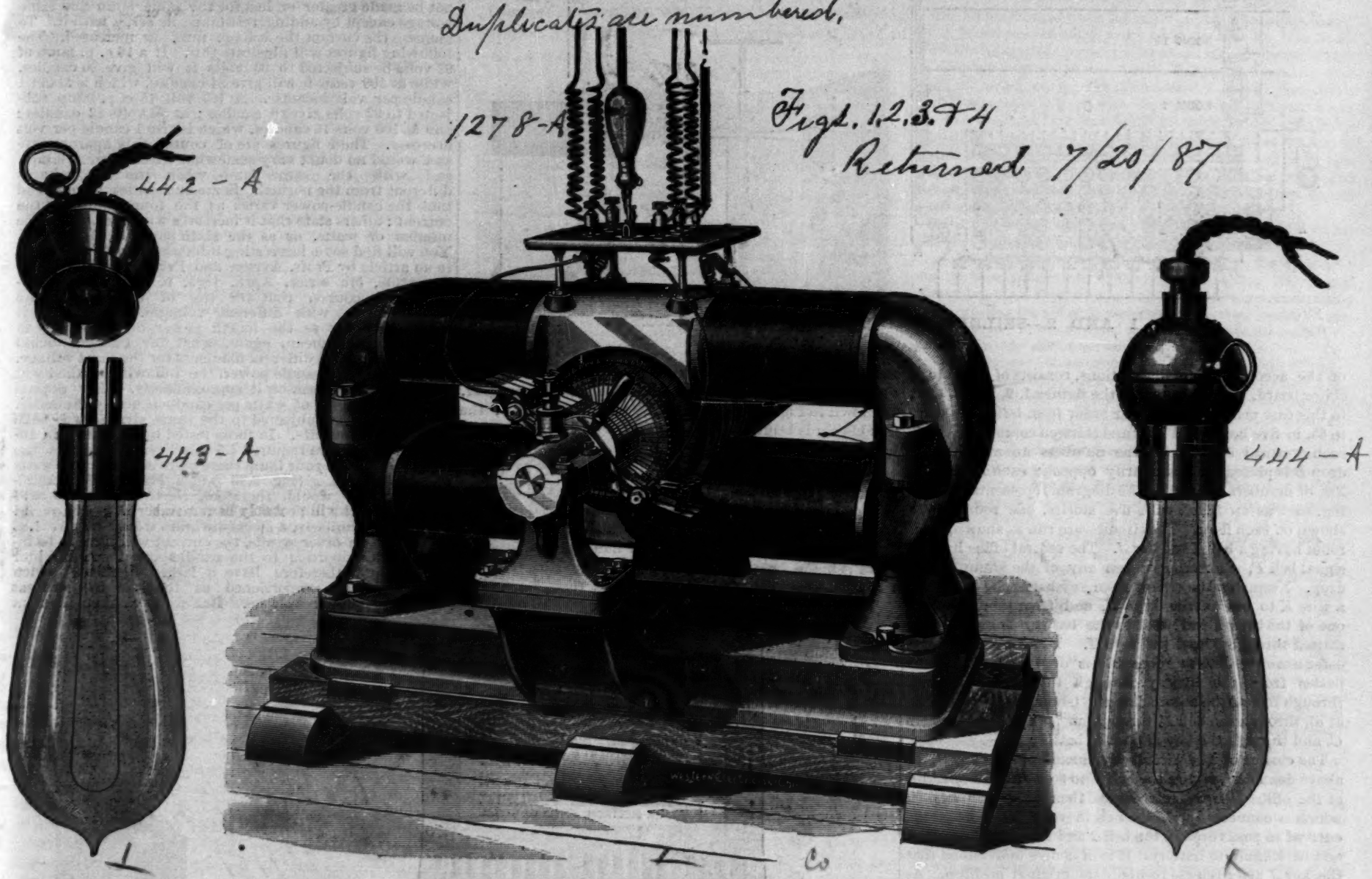
The conditions under which a motor running upon a telpher line is worked are necessarily such as to submit the apparatus to an extremely severe test. The protection which can be given against the weather is very slender at the best.

It is under such conditions that the Immisch motors at Glynde are now working with complete success. This satisfactory result has not, however, been attained without a good deal of painstaking attention to matters of detail both on the part of the Immisch Company and of Mr. Crakanthorp. The Immisch Company at one time sent one of their representatives (Mr. A. Snell), to stay for some time upon the spot in order to study the working conditions as completely as possible. The results now attained will be appreciated from the statement that the motors frequently run for a fortnight without even having their brushes readjusted. The commutators receive a touch of vaseline from the switch man at the end of every journey.

The average E. M. F. along the whole line is 170 volts, there being only a volt or two difference between the engine house and the extremities of the line. The total current taken by the three trains amounts to 20 ampères; but owing to the admirable action of the automatic circuit-closers governing the speed of the trains (a feature which is due to the late Prof. Fleeming Jenkin) it is comparatively seldom that the full current is taken for more than a very short interval. The variations of current between 8, 14 and 20 ampères, as shown in the engine-room ammeter, follow one another in rapid succession. The loss by leakage is two ampères. The governors, it will perhaps be remembered, act by centrifugal force, entirely cutting off the current when the speed of the armature exceeds a certain point. The break is made first on carbon and afterward on copper contacts. Although the gradients on the line are very slight, the trains sometimes run over 100 yards without taking current. The speed of the trains, as judged by the eye, is remarkably uniform, a velocity of about four miles per hour being maintained throughout the whole line, both by empty and by full loads. The trains are started at either end, through a set of resistances, which are cut out in four sections, so that the start is effected with great smoothness.

In the engine house the Ruston and Proctor semi-portable engine and the Crompton compound-wound dynamo both look good for many years to come, although, owing to the continuous variations of the load (through the action of the motor governors), it may be assumed that the work is of a somewhat trying character.

We will only add, in conclusion, that the result of our visit has been to impress forcibly upon our mind the fact that, upon the technical side, telpherage must no longer be looked upon as a scientific toy, but has become a thoroughly practical and efficient system of transport, combining the qualifications of cheapness, simplicity and certainty—a system which, while not intended to compete with steam for heavy traffic, is yet capable of affording a complete solution of an important class of problems in the industrial development of old countries as well as of new colonies and of semi-civilized lands. We do not, however, anticipate, nor is it on the whole desirable, to see "a boom" in telpherage; but that, under capable management, the business of the Telpherage Company will steadily grow into industrial importance we regard as a certainty.



FIGS. 1, 2, 3 AND 4.—THE FORT WAYNE JENNEY INCANDESCENT SYSTEM.

The Fort Wayne Jenney Incandescent System.

For some time past the Fort Wayne Jenney Electric Light Company has been elaborating a system of incandescent electric lighting under the supervision of its electrician, Mr. Schaefer, and the result has been the construction of dynamo and lamps of novel design. In the accompanying engravings, for which we are indebted to the *Western Electrician*, Fig. 1 represents the new machine, in the design of which the aim has been to supply high magnetic strength by a plentiful use of iron, and at the same time to reduce the amount of copper both on armature and field. Thus the resistance of the former is cut down to such a point that the ratio of the resistance of the shunt winding of the field to that of the armature is very high and the machine is practically self-regulating for all loads. The field magnets are of the consequent pole type with but two joints and rest upon a base from which project the brackets supporting the armature. The core of the armature is built up of iron discs insulated from each other so as to avoid Foucault currents.

The new lamp and socket, which are shown in detail in Figs. 2, 3 and 4, are so arranged that the lamp is firmly secured by merely pushing it into the socket.

The same company has also elaborated a long distance incandescent system with lamps in multiple series. In this manner the lights may be run to long distances from the station with but a small percentage of loss in the wires.

With the new type of lamp, it is claimed that 200 candles per horse-power is obtained, and that the life exceeds 1,800 hours.

A Simple Form of Electric Pen.

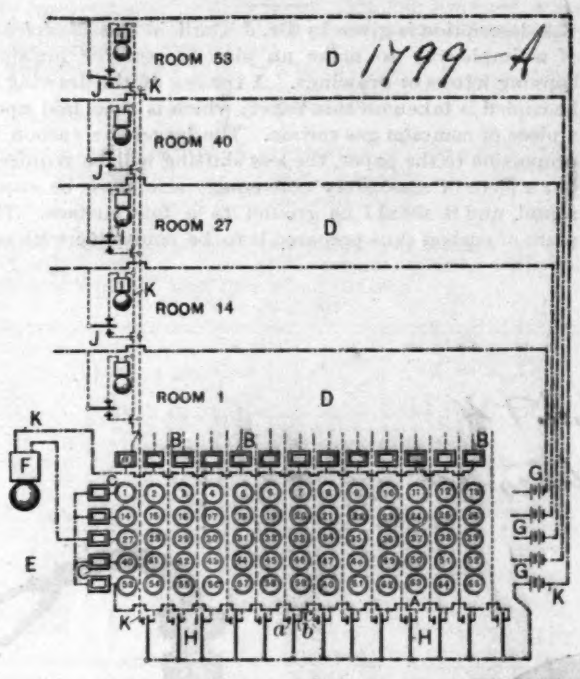
A description is given by Dr. J. Carll in the *Electrician* of a simple way to make an electric pen for multiple copying letters or drawings. A tracing of the drawing to be copied is taken on thin paper, which is then laid upon a piece of common gas carbon. The larger the carbon in proportion to the paper, the less shifting will be required, but a piece of reasonably convenient size may be easily found, and it should be ground to a fair surface. The plate of carbon thus prepared is to be connected with one of the binding posts of a small induction coil, such as that used for an electric bell. The stylus for following the design is nothing more than a lead pencil, rather hard and brought to a fine point. The other end of the lead of the pencil is connected by a wire with the other screw of the induction coil, which in turn is connected with a suitable battery. The wood of the pencil effectually insulates the current from the operator's hand. The arrangement being thus completed, all that is necessary is to follow the design, or to write the letter upon paper resting on the block of carbon, leaning lightly upon the pencil. As the graphite point proceeds, a continuous succession of small sparks flow between it and the carbon, and the intervening paper is accordingly perforated by an infinite number of small holes burned by the sparks. These holes are barely visible to the naked eye, except by holding up the paper to the light, but they can be utilized for transferring the design or writing to paper either by dusting on a powder or passing an ink pad over the perforations when laid on the recipient.

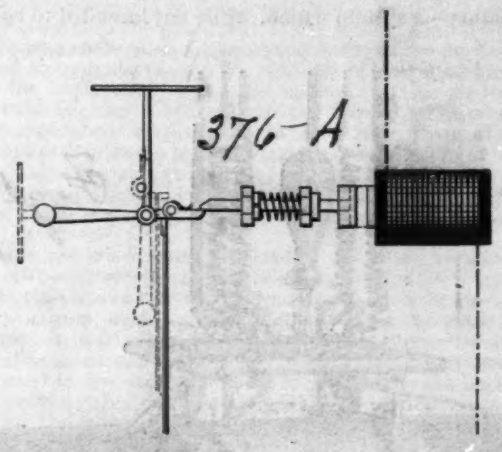
As a Servant of Man.—A great deal of writing is being done now-a-days to convey popular information on the subject of electricity. It is to be found not only in books and magazines but in the daily papers. Thus, in a recent issue of the Lancaster, Pa., *Inquirer*, we find an admirable article on the dynamo and its work by Mr. Horace N. Engle, who tells how the electric current is generated, and describes the uses to which it is put.

Seiler's Hotel Annunciator System.

In hotel annunciators as usually designed, each room has a corresponding drop on the annunciator board, so that in large hotels the number of magnets, etc., is quite considerable, with corresponding liability to derangement. In order to avoid this multiplication of apparatus, and at the same time to provide a means by which the attendant at the office can signal to the occupant of a room that his call has been received, Mr. Paul Seiler, of San Francisco, Cal., has recently designed and patented a system in which the number of annunciator drops required for a given number of rooms is greatly reduced, and a return signal can be given.

The system, which is shown diagrammatically in Fig. 1





FIGS. 1 AND 2.—SEILER'S HOTEL ANNUNCIATOR SYSTEM.

of the accompanying illustrations, consists of an annunciator board, provided with the figures 1, 2, 3. 4, 5, etc., in this case arranged in regular order from left to right up to 65, in five horizontal lines and thirteen columns. Above each vertical column of the numbers an annunciator drop *B* is placed, and similarly opposite each horizontal line of numbers a drop *C*. The diagram represents a building, such as an hotel, with five stories, one room being shown on each floor. The circuits are run as shown, each room having a bell *I* and key *J*. The central office has the signal bell *F*, which rings when any of the annunciators drop. Normally the circuit from any battery *G* passes by a wire *K* to one of the keys *J*, and from there through one of the bells *I* and back to the battery from which it started through one of the keys *H*. But when any key *J*—for example that in room 53—is depressed, the circuit passes from the battery through the depression key, through one of the annunciators *B* (shown in this instance at *a*), through the bell *F*, through one of the annunciators *C*, and through the key *H* back to battery.

The closing of the circuit by means of the key *J*, as above described, causes the bell *F* to sound. An operator at the office thereupon actuates that particular key *H*, which is connected with the bell in room 53, causing the current to pass through the bell *I* and key *J* in that room, and back again to battery. It is of course understood that the key *J* after release resumes its original position. As soon as the bell *I* rings the occupant of room 53 knows that his signal has been received.

The rooms 1, 14, 27, 40 and 53, each represent any room, respectively, on the first, second, third, fourth and fifth floors. Taken together they represent what may be called a "section," so that when the annunciator marked *a* drops, one of the rooms in this section calls the office. The particular room in that section is indicated by one of the annunciators *C*. That is to say, the annunciators *C* represent the different floors or stories in a hotel or other building. The annunciators *B* represent different rooms arranged above one another in the same building. Any one of the annunciators *B* may stand for four or five more different rooms. It is only by reading the two annunciators together that one can know which of the numbers is represented. Thus, the annunciator marked *a* may stand for 1, 14, 27, 40 or 53. If, however, the lowermost of the annunciators *C* drops at the same time with the annunciator marked *a* it indicates that room 53 has called. For the sake of preventing confusion, only one section is shown connected up with the annunciator board.

The annunciator drop employed by Mr. Seiler is shown in side elevation in Fig. 2. It consists of a drop proper weighted by a projection, and held in position by a catch. The latter is elastically connected with the core of the solenoid located in the circuit *K*. When a current passes through the solenoid, the drop is released by the catch and falls into the position indicated in dotted lines. By means of a string it may be pulled again into its normal position. The art, connecting the drop to the catch, is hinged in such a manner that it will turn upward but not downward.

It will be seen that by means of this system the number of drops is largely reduced in the case illustrated, for instance, 18 drops take the place of 65, which would be required with the usual system.

A Novel Medical and Testing Battery.

Physicians and those requiring portable testing batteries often find inconvenience in the handling of the olutions, many of which are of a corroding nature; and hence some convenient form of exciting material for the battery is desirable. In a new form of battery designed for this purpose by Dr. C. Piper, of Moline, Ill., and made by the Electrical Supply Company, of Chicago, the cells are placed in a case together with the appliances for charging, as shown in Fig. 1. No binding posts are employed, the flexible cords being tipped with terminals which are placed in the contact slots *F, F*.

The cells employed are shown at *A* and more in detail in Fig. 2. It will be seen that the carbon and zinc are clamped together with insulating material placed between them. The cavity thus formed contains the solution. The cells measure $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$ inch, and contact between them is made by the screw *B*, which presses them all together. In each of the cell cavities there is placed a slip of prepared paper covered with a crystallized mercuric

FIGS. 1 AND 2.—NEW MEDICAL AND TESTING BATTERY.

and potassic nitrate salt. The cell is then filled with water by means of the dropping tube *H*, and the battery is ready for work. The chemical employed being rich in nitric acid, polarization does not take place, as the hydrogen is immediately oxidized by the acid and converted into water.

The induction coil *D* is furnished with a sliding shield which regulates the strength of the current effects, but these can also be varied by the contact points *F F*, into which the terminals *E E* can be inserted. In this way four different forms of current can be obtained, viz: a continuous galvanic current; an interrupted galvanic current; a faradic current; and finally a faradic and continuous galvanic current combined. An arrangement is also provided by which any number of the cells can be cut in or out at will.

The E. M. F. of the Piper cell is 1.65 volts per cell, so that this combination of 20 cells gives a greater number of volts than 30 ordinary Daniell cells. The constant of the battery is shown by the following experiment: In a circuit which included a galvanometer coil of 800 ohms, the current from a single cell was run for twenty-four hours. When it was perfectly fresh, the needle was deflected 75 degrees. At the end of twenty-four hours it had only fallen off a single degree. The entire medical battery combination weighs only 3¼ pounds. The testing battery, of course, contains none of the coils of the medical apparatus. In other respects it is similar to it, but occupies less space, though both can be conveniently carried in the pocket.

Currents for Lamps of Different Candle-Power.

To the Editor of The Electrical World:

SIR: Please inform me in what proportion does the candle-power of an incandescent lamp vary by an increase or decrease of current. For instance, suppose that .6 ampères at 100 volts yields 16 c. p., what would be the current for a candle-power of 25, 50, etc., at the same voltage?

PITTSBURGH, Pa. H. E.

ANSWER.—If you mean varying the current of a certain lamp without varying the voltage, we would say that this cannot be done. A lamp will take a certain fixed current if run at a definite voltage, and this current cannot be made greater or less for the same lamp and same voltage except by adding resistance in series with it. To increase the current the voltage must be increased. The following figures will illustrate this. If a 16 c. p. lamp of 92 volts be subjected to 96 volts it will give 20 candles, while at 100 volts it will give 24 candles, which is about 1 candle per volt increase. A 100 volt 16 c. p. lamp subjected to 92 volts gives 8 candles; at 96 volts 12 candles; and at 100 volts 16 candles, which is also 1 candle per volt decrease. These figures are of course only approximate and would no doubt vary somewhat with different lamps, and with the same lamp when run at voltages different from the normal. Some authorities have found that the candle-power varies as the fourth power of the current; others state that it increases with the cube of the number of watts, or as the sixth power of the current. You will find some interesting information on this subject in an article by Profs. Ayrton and Perry in *Philosophical Magazine*, 5th series, April, 1885, p. 304. It is understood, of course, that the life of the lamp varies very greatly with different voltages. Some say it varies inversely as the fourth power of the energy in watts. If you mean, again, what the current should be for lamps with different filaments for the same voltage, but of different candle power, the following method will enable you to determine it approximately. For normal lamps the number of watts per candle is nearly the same, if the lamps are subjected to the same strain and have about the same life. In those tested by the Franklin Institute, the Edison required 4.5 watts per candle, and the Weston 3.7. In your lamp there were $.6 \times 100 = 60$ watts for 16 candles, giving 3.75 watts per candle. A 25-candle lamp would, therefore, require $25 \times 3.75 = 94$ watts, which, at 100 volts, gives $94 \div 100 = .94$ ampères. Similarly, a 50-candle lamp would require 1.88 ampères. In other words, the current will have to be increased in proportion to the candle-power. A brighter lamp must therefore have a larger filament, which should be so proportioned as to take this current with the proper voltage. But as a thicker filament of the same length will be stronger and less liable to break or burn out at a weak spot, it can be subjected to a greater strain. Such lamps generally yield a higher efficiency; that is, require less watts per candle, which means that they may be raised to a higher temperature. The current may therefore safely be taken somewhat less than the above calculation would require. For instance, an Edison 8-candle and a 16-candle lamp both at 51 volts required .745 and 1.2 ampères respectively. A 32-candle lamp at 102 volts required 1.19 ampères while a 16 c. p. lamp at 105 volts required .75 ampères.—EDS. E. W.

Burning of the New Zealand General Post Office.—The fine post office building at Wellington, New Zealand, was destroyed recently by fire, the loss being estimated at over $150,000. The telegraph room and the telephone exchange were completely wiped out, and another loss was that of the electric light apparatus which had but recently arrived from England, and was in course of erection.

"Wheatstone and the Word 'Telephone.'"

To the Editor of The Electrical World:

SIR: One of the peculiar features of articles written for the electrical papers, is that they seem to be read piecemeal. I find in your last issue a letter signed by Silvanus P. Thompson, illustrative of this feature. In that letter, he undertakes to correct my information concerning Wheatstone's use of the word "telephone."

It is evident that like the first gentleman who undertook to criticise my paper on this subject, he has not read or examined the said paper.

For the information of all persons who hereafter may desire to consider this subject, I will state that the paper in full is to be found in the New York *Electrician and Electrical Engineer*, for April, 1887, pp. 131—133.

Prof. Silvanus P. Thompson says I have made "complaint that Wheatstone did not himself use the word telephone."

What I said on this head was the following, and is found in paragraph 3, column 1, page 132: "I have been somewhat disappointed to find that *in these papers* Wheatstone himself does not employ the word 'telephone.'"

I am sure Professor Thompson himself must sometimes have been amused to find that critics and commentators pick out paragraphs in his writings to correct without ascertaining whether there is anything to correct or not.

If he had taken the pains to look at the fifth paragraph in the next column he would have found the following:

"We now arrive at Wheatstone's British patent, No. 2,462, of 1860, in which he claims, among other inventions, 'The employment of musical pipes or free tongues acted upon by wind in the construction of telephones, etc.'"

Now with respect to the remainder of Professor Thompson's letter in which he seems to intimate that I have not paid sufficient respect to the farinaceous fetish he has set up and before which he offers perpetual worship, I may say, the paper I wrote expressed no opinion whatsoever regarding the respective merits of Reis, Wheatstone, Bell or any one else, as inventors, or regarding their several inventions. That paper was intended only to show that the word "telephone" was not exclusively applied to the articulating or speaking telephone as now generally understood, but was much older, and had been applied to a number of differing devices.

But if the respective merits of these gentlemen are to be considered, I am content to appeal from Thompson, of 1883, the advocate and special pleader for Philipp Reis, to Thompson in 1881, the author of "Elementary Lessons in Electricity and Magnetism," and his assertion that "In 1876 Graham Bell invented the articulating telephone;" from January 1st, 1876, when there were no speaking telephones in the United States or anywhere else, to January the first, 1887, when there were 353,518 telephones in use in the United States and 75,000 in Europe; from the fact that prior to January 1st, 1876, no patent for a speaking telephone had been issued in the United States, but that since that period 633 such patents have been issued from the United States Patent Office alone.

Candid observers cannot fail to note these facts, and form judgment accordingly. THOMAS D. LOCKWOOD.

BOSTON, July 11, 1887.

A New Unit of Time.

M. Lippmann, the distinguished savant, has proposed to the French Academy of Sciences the substitution of a new unit of time for the ordinary second, which he regards as an arbitrary and variable unit. The unit proposed would be an electrical resistance, which can be shown to represent an interval of time—the resistance, say, of a cube of mercury. M. Lippmann gives a method of practically determining the unit by means of an artificial resistance and condenser, apparatus which he considers likely to be more constant than the standard clock time piece.

The Aron Electric Meter.

For some time past the electric meters of Dr. Aron, of Berlin, have been in use on the Edison circuits in Germany, and it is said that their performance is so satisfactory that over one thousand of them are now in service.

The principle upon which they work is that of the differential clockwork gear, as first brought out by Professors Ayrton and Perry. This method consists in employing two clocks, one a standard and the other acted upon by the current passing, so that its rate is altered proportionally to the current passing, or the difference of potential, if employed in connection with arc circuits. The difference in rate of the two clocks operates upon a recording train, which registers the amount of current passing through the meter.

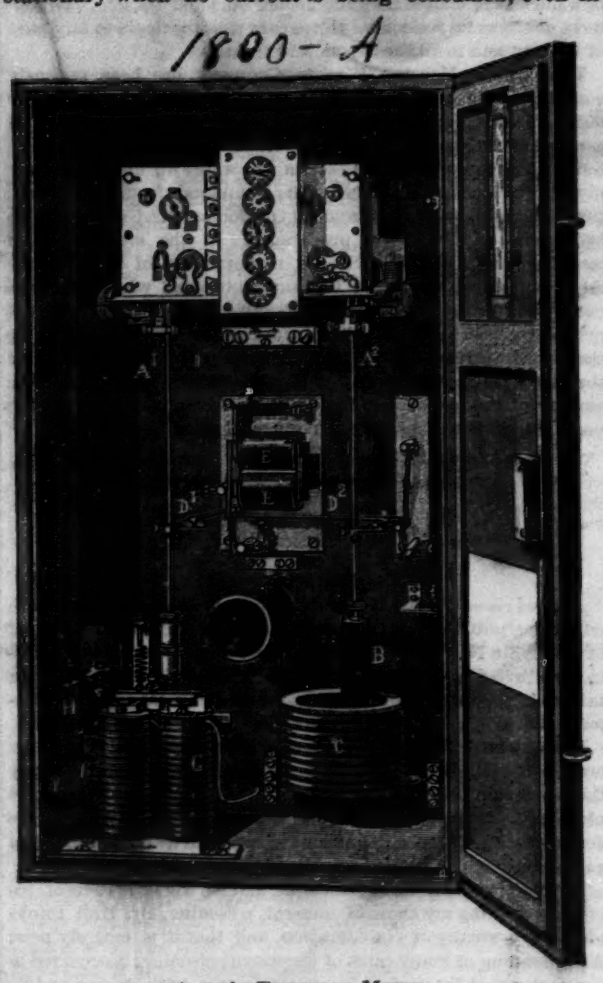
The old form of Dr. Aron's meter embodied some objectionable features, and it was in order to remove these that the new form was designed.

It is well known that the duration of the oscillation of a pendulum is varied by an alteration of either its length or weight. The application of this principle is used in the construction of the Aron meter, illustrated in the accompanying engraving.

Two pendulums A^1 A^2 are worked by two distinct clockwork gears. One A^1 is a standard, and oscillates at a regular speed; the second A^2 has a permanent magnet B, instead of a weight, and is variable in its speed. The variation is obtained by passing the whole current through a solenoid of thick wire C, placed underneath (but not touching) the magnet B. The magnetic influence has an accelerating effect on the pendulum A^2 in direct proportion to the current passed through. This produces a corresponding increase in the speed of the clockwork gear regulated by this pendulum.

A direct reading of variation in the speeds of the standard and variable clockwork is given by an ingenious differential gearing with speed-counting dials, calibrated to read in direct units, on the same principle as a gas meter. The slightest alteration in the current consumed is recorded by the whole current being passed through the solenoid C. Both pendulums are controlled by catches D^1 D^2, which are again controlled by the armature of an electro-magnet E, placed in a shunt circuit. These catches form a self-starting gear and work as follows: An electro-magnet G is wound with wire the same size as that on the solenoid C, and placed in series with that solenoid. The armature of this electro-magnet has attached to it a spring H, which, when the armature is closed, closes the shunt circuit, causing the controlling magnet E to release the pendulums.

This arrangement also insures the recorder remaining stationary when no current is being consumed, even in



ARON'S ELECTRIC METER.

the event of the main switch between the service mains and the house being left shut. Objections may be raised to the use of clockwork, but if it is well made, as in the present instance, it can be as thoroughly relied upon as a good clock itself. In this improved meter the clockwork winding lasts eighteen days, if in constant use; but if in part use, as is generally the case, it will serve for two months.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
NEW YORK, July 11, 1887.

Last Wednesday I had the pleasure of walking through the beautiful vestibule train run by the Pullman Company on the Pennsylvania road as the Chicago Limited. As is generally known, the cars are all connected together, so that in going from one to the other the passenger does not have to jump at the risk of his life from one open platform to the next, but simply walks through a hallway. The cars I saw—the "America," "England," "France," "Servia," "Esperanza" and "Vendome"—are all specimens of the latest skill and taste in such work, and, as you have already noted, are all equipped with the storage cells of the Electrical Accumulator Company. Each car has thirty cells, size 7 B, giving 20 ampères for 6 hours, and now being drawn on so as to furnish current for 10 hours. There are 22 lamps to each car well distributed. Mr. Conant, of the Accumulator Company, who escorted me through the train, was most obliging in explanations, and showed me also the storage room, where a Griscom dynamo is in service for charging.

I referred incidentally to the work now being done with accumulators in some of our largest New York office buildings by the Isolated Accumulator Company, which uses the E. A. cells. Mr. H. E. Vineing is the electrician and Mr. A. A. McCreery the manager of the Isolated Company, and these gentlemen have not only done considerable good work already, but are busy with very extensive plans for the present and future. One of their plants was shown me last week by Mr. J. M. Robertson, the engineer of the Mills Building, where 100 cells have been put in. There is an Edison plant of 1,300 lights, and these cells now furnish the current for 100 lights for 10 hours at night, when the building is comparatively empty. Hence, there is no longer any necessity to run the generating plant after regular office hours, except perhaps on very special occasions, when more than a hundred lights might be required. It is in such a manner as this that a good storage battery comes into play, not only as an element of convenience, but as one of economy also. The plant in question has been well installed, and, like a good engineer, Mr. Robertson has a full set of measuring instruments at his command, including hydrometer, Ayrton & Perry voltmeters and ammeters and Edison testing sets.

The Board of Electrical Control met last week in the Mayor's office. Mr. Edward Lauterbach, for the Consolidated Telegraph and Electrical Subway Company, submitted the form of a bond, with a surety, as required by the board, and a committee will examine it. Mr. Gibbens presented a report on the subject of permits for placing or maintaining new wires on overhead structures. The report involved a general system of regulation for all overhead wires as well as of the subways. Mr. Beekman suggested that the questions involved were very important, and that the report should be printed and that the opinion of the Commissioner of Public Works be obtained on the subject. Mr. Gibbens thought the suggestion was quite proper, but, as he had looked into the matter very carefully, he spoke of the immediate necessity of exercising a complete supervision over the poles and wires.

President Hess submitted a long list of routes desired by the Metropolitan Telephone Company, covering 782,600 feet.

The Edison Company also submitted a list of conduits desired by it, which covered nearly every street in the city. The North New York Lighting Company submitted a request for permission to maintain overhead lines. All the documents were laid over until the next meeting. The Consolidated Company gave notice that it was ready to go on with the route from Cortlandt street up Broadway and Park Row to the Brooklyn Bridge and Chambers street; the route on Broadway, from Canal street to Spring street, and down Spring street to West street, and with new extensions on West Houston street, East Houston street and Grand street, and the route on Fifty-eighth street from Eighth avenue to near the East River.

At Mr. Beekman's suggestion, the engineers of the Metropolitan Telephone Company and the engineer of the board and of the Consolidated Company were directed to confer on the subject of making house connections. In answer to the acting Mayor, Mr. Kearney said the Sixth avenue subway had not yet been tested to see whether the arc or incandescent light wires could be carried therein. It was intended to construct a separate conduit for the electric light and power service.

Commissioner Gibbens moved that the Consolidated Company be instructed to begin work on the routes laid out by the former Subway Board within ten days. Mr. Beekman objected on the ground that he wanted further information on the subject, and would not vote on the question. The vote was adopted by the concurrence of the other Commissioners. A motion by Mr. Gibbens to employ six inspectors to make a report on the condition of overhead wires throughout the city was laid over until the next meeting. President Hess had a resolution adopted calling for the removal of all wires on poles or housetops not in actual use or operation. He said that fully 30 per cent. of the overhead wires were known as "dead wires," and could be removed.

Mr. John R. Dos Passos, who is counsel of the company organized in Philadelphia to bid for the construction of the subway, is still endeavoring to hinder the work of the Board of Electrical Control in its proceeding under the new law. He says: "We will begin an action on the ground that the new law is entirely unconstitutional. I told Governor Hill before he signed it that it was never constitutional, but he never considered the fact or mentioned it in his message, so on his head rests all the blame. Our papers are being prepared now, and a bill will be brought at the proper time. No delay at all need occur in the action of the commission, however, because if they proceeded under the old act there would have been no trouble. The interest I represent is an entirely new one, which has never appeared upon the scene before. I cannot disclose just now the extent or exact nature of the interest, but that will duly appear. We intend to demonstrate that this legislation is entirely illegal, and I think when you see the demonstration which we will make that you will agree that the carrying out of the commission's proposed course of action is altogether impracticable."

Papers were served on Acting Mayor Beekman, on July 11, in a suit brought by Peter McGinness in the Superior Court to restrain the city authorities from carrying into effect what is known as the new Subway bill, establishing the Board of Electrical Control. The complaint comprises an affidavit by D. Morgan Hildreth, Jr., and a summons to show cause on July 14 why an injunction should not be issued staying all proceedings on the part of the city authorities to carry the subway contracts into effect until after the determination of this suit. Mr. Hildreth is the president of the New York Underground Telegraph Company. He alleges in his affidavit that the contract of the Subway Commissioners with the Construction Company was the result of a corrupt deal or bargain, and he founds this charge on the testimony elicited in the Flynn-McMahon suit in the United States District Court. He alleges that the contract was entered into without competition, and that the effort to confirm and perpetuate the corrupt contract was and is made for the purpose of subserving the personal and private aims of the individuals concerned in the Construction Company, and not for the true interests of the city of New York; that it would, if carried out, result in the manifest injury to the estate funds and property of the city; that unless the court intervene, the work will be begun and thus occasion waste and injury to the funds of the city.

Other affidavits are appended, and it is freely alleged that the law as it stands, establishing the Board of Electrical Control, is not upon the statute book for various reasons.

The New York Electric Lines Company, through its president, Mr. Sidney Shelbourne, has asked Judge Potter for a mandamus to compel the Commissioner of Public Works to allow it to lay its own conduits.

The main object of the suit is to have the new subway act declared unconstitutional.

By the terms of an ordinance adopted some time ago by the

Brooklyn Board of Aldermen the Commissioner of City Works is forbidden to grant permits for the opening of the streets for the purpose of burying electrical wires without the consent of the Aldermen. This has prevented the Subway Commissioners from carrying out their plans for placing the wires under ground, and they have now appealed to Mayor Whitney for assistance. He wrote a long letter to the Aldermen finding fault with them for their apparent obstructive policy, and intimating very plainly that they were acting in the interest of the telegraph and telephone companies. The Mayor urged the Aldermen to repeal the prohibitory ordinance before they adjourned over the summer, but the opposition of Aldermen Weeks and Coffee prevented such action. They complained that the Subway Commissioners had snubbed the Aldermen, and saw no reason why the latter should gratify them now. Weeks moved that the Mayor's communication be referred to the Law Committee, and it was.

The Safety E'ectric Construction Company, 41 and 43 Wall street, J. Murray Mitchell, counsel, is ready to construct and equip electric roads especially on the Daft system. The Asbury Park, N. J., road, for the Sea Shore Electric Railway Company, now has 4 miles of roadbed completed. The overhead system will be used, with 15 cars, the motor being placed under each car. A speed of 12 miles an hour is to be attained, and low tension current will be used.

The old and well-known house of E. S. Greeley & Co. has taken important action and one that betokens a fine spirit of liberality and appreciation, in admitting several old and valued employés into partnership, the new organization being incorporated as "The E. S. Greeley Company." The change dates from July 1. The personnel of the management, the capital employed, and the business policy of the firm will remain as before. General E. S. Greeley retains a controlling interest and will continue in the general management; Mr. Arthur Parker, for several years an associate in the firm, retains his old interest and the special direction of the Southern sales department; and the new members of the firm will be thus occupied: Mr. M. W. Goodyear in charge of the electrical department; Mr. J. Bailey, Western sales department; Mr. E. S. Riggs, home office of the railroad department; and Mr. J. W. Sands, book-keeping and cashier's department. The firm as it pushes forward under its new conditions, has many a well wisher. I know that the host of friends that Mr. Goodyear has in the electrical business will be pleased to note this pleasant episode in his career.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
BOSTON, July 11, 1887.

The town of Quincy, Mass., is to have an electric light station. It is reported that Messrs. Durgin & Merrill, two enterprising business men of that place, contemplate erecting a plant at an early day.

The electric light company recently organized at Southbridge, Mass., has been awarded the contract for lighting the streets of that town with arc lights. The American Optical Company deserves the credit for its enterprise in being the first user of electricity as an illuminant in the town named.

Messrs. Paine & Francis, New England agents of the Edison United Manufacturing Company, have just filled an order for F. E. Reed, the well-known lathe manufacturer, at Worcester, Mass., this being for increase of an isolated incandescent plant in the works of the latter from 100 to 200 lights.

Mr. N. J. Simonds and a few other enterprising citizens of Woburn, Mass., have increased the lighting capacity of the electric light plant installed by them in that town a little over a year ago by the addition of more arc and incandescent lights. After obtaining the contract for lighting the streets of Woburn the promoters incorporated the Woburn Electric Light and Power Company, having a capital stock of $18,000, and with Mr. Simonds as president.

Messrs. Thomas B. Adams & Co., 31 Federal street, Boston, have received an order for their dynamo belting from the Emporia State Electric Company, of Atlanta, Ga. This firm is said to be enjoying a large trade with electric light companies and electrical goods manufacturers. Several of their oak-tanned leather belts (double) were recently shipped to Messrs. Benjamin Hey & Co., manufacturers, Cincinnati.

The Thomson-Houston Electric Company continues to add to its already large list of local electric light companies. In New England alone plants have been fitted up with the Thomson-Houston systems of arc and incandescent lighting since the beginning of May of the present year in the following towns, viz.: Newburyport, Mass., 60 arcs; Greenfield, Mass., 45 arcs and 500 incandescents; Millbury, Mass., 50 arcs; Amesbury, Mass., 80 arcs; Keene, N. H., 65 arcs.

My attention is called to an "automatic electric heat regulating system," invented and developed by F. M. Sparrow, Mattapoisett, Mass. The current obtained from a battery of four to six ordinary open circuit cells generates the only power required for the complete operation of this system for two years or more, and the entire care and attention is to recharge the battery at the end of that time. The system is easily applied to all forms of heating, regulating the fire draughts and dampers of hot air and steam furnaces, controlling the floor registers and ingress and egress valves of steam radiators. The mechanism has few moving parts, is strongly made and will not get deranged, and its construction is such that a large surplus of power is developed. On account of its simplicity and easy application, the system is not expensive. Any person having a furnace can certainly afford it without reckoning the saving of fuel resulting from its use. Such at least are the claims made.

The Jarvis Engineering Company, of Boston and New York, reports the following orders it has filled since the first of the month, viz.: A tubular boiler set with the Jarvis boiler setting for the Torrington, Conn., Electric Light Company; another tubular with same style of setting for the Thomson-Houston Electric Light Company at San Antonio, Tex.; re-equipping the steam plant of the Mobile (Ala.) Electric Light Company; and the fitting up of the entire steam plant—including four tubular boilers with Jarvis setting—for the Austin, Tex., Electric Light and Power Company.

At a meeting of the Boston Board of Aldermen, on July 5, it was voted that the Joint Standing Committee on Underground Wires be authorized to visit the cities of New York, Brooklyn, Philadelphia and Washington, for the purpose of inspecting the underground wire systems in operation in those cities; and it was agreed upon also that the Boston Electric Light Company be authorized to acquire all the pole rights of the Brush Electric Lighting Company, Merchants' Electric Light and Power Company, and the New England Weston Electric Light Company, granted to them respectively by the Board of Aldermen; and the order that the Brush Electric Lighting Company, of Boston, the Merchants' Electric Light and Power Company, and the New England Weston Electric Light Company, be authorized to transfer to the Boston Electric Light Company all the pole rights that have heretofore been granted to said companies, respectively, by the Board of Aldermen, was passed.

One of the most novel systems of ventilation yet devised has recently been installed in the Bijou Theatre, Boston, by the American Ventilator Company. Fresh air is carried through small pipes to every seat by the aid of a Sprague electric motor, located under the auditorium, connected with a large blower which furnishes the supply of air. The large restaurant of Messrs. Russell & Sturgis, on Washington street, is supplied with the same system. The supply of air can be regulated by the occupant of each seat.

The committee on headquarters of the Boston Electric Club have decided to take two entire floors of the handsome building at No. 66 Boylston street, for which the rental will be $2,280 per annum. The two floors are to be portioned off at the owner's expense to suit the requirements of the Club, a hall for meetings, secretary's room, reception room, committee rooms, etc. The building is situated in one of the most attractive and desirable localities in Boston. It fronts on the Common and is in the midst of a nucleus of club-houses and homes of some of the "Hub's" most aristocratic residents. Horse cars pass the doors to any part of the city and to all the depots and theatres.

The Thomson-Houston Electric Company has been seriously considering the advisability of manufacturing carbons for arc lights since the early part of May this year. This step is now an assured fact, the company referred to having purchased a large building lot in the town of Fostoria, O., where an unlimited supply of petroleum coke will be at its command from a source entirely independent of the Standard Oil Company. Ground will be broken in a few days preparatory to the erection of a large factory for the exclusive manufacture of carbons for electric lighting purpose. The superintendent who will have charge of the Thomson-Houston Electric Company's new enterprise has already received his appointment, and he will look after the more important details in the building and the equipping of the factory. This gentleman (a Mr. Moses) was formerly in the employ of the Richmond, Mass., Carbon Company, one of the concerns swallowed up by the Western Carbon Combination.

W. I. B.

PHILADELPHIA NOTES.

PHILADELPHIA, Pa., July 11, 1887.

Alleged cases of extensive poisoning from eating ice cream are now being published throughout the country. On Wednesday of last week, in New York, half a hundred persons were taken violently ill after eating ice cream made by a prominent dealer. In this, as in the other cases, the cause of the sickness cannot be determined.

Dr. George S. Hull, of Chambersburg, Pa., who was in this city last week, has, after a series of experiments, advanced the theory that ice cream poisoning is due to chemical action which takes place in the ice cream freezer, and which dissolves the zinc. He demonstrated his theory by means of an electrical instrument—a galvanometer.

All of the zinc salts are poisonous, and as the symptoms of ice cream poisoning are those of mineral poisoning, Dr. Hull thinks his theory worthy of consideration, and that it is entirely new. After reading of many cases of ice cream poisoning, it occurred to the doctor that the modern ice cream freezer, with its zinc paddle and tin or copper can, would represent a tolerably good galvanic cell, the zinc being positive and the copper or tin negative, provided the mixture in the freezer would attack the zinc.

Of all the theories advanced as to the cause of ice cream poisoning none as yet have been demonstrated as true, although Dr. Vaughn's tyrotoxicon theory has been accepted as the most plausible. Dr. Hull experimented with ice cream materials that were tested and found to be perfectly pure.

He reasoned that if any chemical action took place between the zinc paddle and the material in the freezer there would be generated a current of electricity, the freezer being so constructed as to warrant this belief.

In order to produce this current the metals must be connected by a conductor or must touch each other, as they do in the modern ice cream freezer. In conducting the experiments the doctor connected the zinc, paddle and tin can by means of a copper wire with a moderately sensitive galvanometer introduced in the circuit. He first experimented with pure cream, which deflected the galvanometer seven degrees at freezing point, thus showing that some slight solution was taking place, and proving that if pure cream caused a deflection of seven degrees, the other ingredients of ice cream would probably cause more, and in such case sufficient zinc would be dissolved in the ice cream as ordinarily made as would make it decidedly dangerous as a delicacy. Continued experiments convinced the doctor that he was on the right track, and the deflections caused by the various other substances used are given below.

Half cream and milk, 25 degrees; pure milk, 45 degrees; one-half cream, half milk, sugar and vanilla flavor, 58; the same mixture with corn starch, 44; the same mixture with eggs, 80.

When these materials are allowed to stand so as to become partially sour the deflection was greatly increased. Ice cream containing acid fruits or other acids will cause still further deflections, and in cases where salt finds its way into the cream, which is frequently the case, the solution of the zinc is much hastened. Dr. Hull, who is a graduate of the University of Pennsylvania, is continuing his experiments, and says that he is not half done. The theory has been the subject of considerable discussion in this city, and further developments are anxiously awaited by those interested in the matter.

The Brush Electric Company of Cleveland, O., have opened a branch office in this city, for the purpose of contracting for the installation of isolated plants. They are at present located at No. 53 South Third, and Mr. Edward W. Tisdall is the special agent, while Mr. L. Porsh is the consulting and contracting electrician. Nearly every one of the prominent companies now have branch offices in this city, and, with the wonderful growth in the number of isolated plants hereabouts, they are doing a rushing business.

James W. Bonta, of this city, was last week granted six different patents for a telephone transmitter, all of which were assigned to the American National Telephone Company of New York.

Henry Carey Baird, the book publisher, is still mourning the almost total loss of his baggage, which occurred during his recent trip from Paris on one of the French Transatlantic steamers. He finds some consolation, however, in the fact that the trip was so valuable in other ways.

On his recent visit to this city, Mr. Thomas A. Edison was accompanied by his wife and sister, and they enjoyed several pleasant drives through the park during their short stay.

Last Friday evening Mr. David Brooks delivered an interesting address before the Electrical Section of the Franklin Institute on "Ohm's Laws."

News of progress with the "Dynamograph," an electrical typewriter, is expected very soon, as arrangements are now in progress for a test on a line from this city to Baltimore, to take place within a fortnight.

Shaw and Geary are working a large force of men on a contract for a printing telegraph machine which is expected to be ready for actual work within a short time. It is an ingenious piece of mechanism.

The Faraday Carbon Company, Limited, of Pittsburgh, is another applicant for the favors of electric light people, and as it has a large capacity and manufactures a fine quality of carbons it will undoubtedly receive a good share of the patronage.

The Penn Electric Light Company, who have an exclusive franchise for underground conduits, are laying a 20 compartment wooden conduit, almost the entire length of Chestnut street, and as they are limited to a certain time, work is being carried on night and day. The sectional iron conduits on the other side of the street are also being replaced by similar ones of a much larger capacity.

E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
CHICAGO, July 2, 1887.

The following taken from a daily paper is of interest in showing the favor into which the electric light has grown in this city: Action should be taken before the City Council adjourns for the summer vacation on the report of the Committee on Fire and Water recommending the lighting of the city bridges by electricity. There is no doubt of the practicability and economy of the proposed plan. It has been approved by the Mayor, the Commissioner of Public Works, and the City Electrician. The estimates for the work have been carefully made and the funds necessary are immediately available. Action in accordance with the recomendation made will not be in the nature of an experiment except as far as it refers to the extension of electric lighting to the whole city. The plant for the bridges may yet be made the nucleus of a comprehensive scheme of city illumination. The greed of the gas monopolists and their extortionate combinations are likely to compel the municipal government to undertake the work of city lighting. Any step in that direction now will be of great advantage hereafter. The partial plan now proposed by the Council committee will be carried on under the supervision of the Commissioner of Public Works. This insures economy, expedition and satisfactory performance. Concerning the great advantages of electric lights over gas lamps for bridges, we have abundant evidence at Lake and Rush street bridges. The greater illumination will not only be a source of pleasure and convenience to the public—it will be a source of security and safety as well. It will facilitate the crossing of the bridges by fire engines, and it will powerfully aid in the night navigation of the river. There have been few recommendations made to the City Council for years that have been so generally acceptable or so likely to prove of permanent and increasing benefit as this one promises to be. The Council should take up the order as recommended at its next meeting or make it a special order for an early date.

In connection with the above, I am pleased to report the passage of the ordinance by the City Council for lighting a portion of the Chicago River, the Council appropriating fifteen thousand dollars for that purpose. The total estimated expense for installing this system is forty-seven thousand dollars.

The ordinance is as follows:

"That the Commissioner of Public Works is hereby authorized and empowered to contract for the construction and maintenance of an electric light system within the limits of the city of Chicago, along and upon the Chicago River and its branches and the bridges, viaducts and ends of streets contiguous thereto, between Halstead street on the South Branch and Halstead street on the North Branch and from those points to the mouth of the river. The Commissioner of Public Works shall designate the route or routes, streets, bridges, tunnels, and viaducts, in and through which said system shall be extended, and shall have full power to prescribe and enforce all lawful conditions and regulations as to the erection and maintenance thereof."

Mr. Chas. Desmond has resigned his position as engineer in charge of the Palmer House plant.

A new electric clock invented by a Mr. Chas. Gifford has been on exhibition the past week at the Briggs House.

Concerning electric motors, I clip the following from a Lima, O., dispatch:

"An old-fashioned Fourth of July celebration took place in this city to-day. A feature of the occasion was the formal opening of the Lima Electric Street Railway, which is equipped with the Van Depoele system of electric motors and generators, manufactured in Chicago. It was the event of the day, and thousands of people cheered the cars in their electrical flight. They were loaded to suffocation all day long and way into the small hours of the morning. Not a single delay or stop occurred, and the

crowded cars seemed to climb grades as easily as they descended. The system is as perfect as mechanism and ingenuity can make it, and our citizens are wild with delight at the exhibition of the powers of subtle electric force. The road is four miles long, and five cars are in operation. The use of horses to propel street cars is a thing of the past in Lima."

Mr. Stiles, of the Van Depoele Company, states that four cars were in operation at Lima, O. The road is, as stated, four miles in length.

This company have contracted for the suburban road at Ansonia, Conn., to be six miles long, of which mention has been made before. This road will present a new feature in running several freight cars. The Van Depoele Company now have a total of eight roads in actual operation.

The Van Depoele Company announce that their Gainesville, Texas, sixty light plant began giving service July 2.

I have received the following from Indianapolis: "Prof. Edmund Hall, of De Pauw College, New Albany, is in the city. The professor has a plan for a street-car motor which he claims will save $4,000 a mile over the cable system. His method of operating cars is by means of levers, two men being required to a car, alternating in operating the levers and doing duty as conductor. He claims that by this method a speed of thirty miles an hour can be attained, while a speed of eight to ten miles an hour is easy and the car can be stopped instantaneously. He has a device for inclosing the wheels so that accidents will be next to impossible."

The Western Electric Company have just issued a new edition of their catalogues. The new book is conveniently arranged for reference, and embodies among other subjects a complete description of their arc light system.

A gentleman is in the city at present endeavoring to secure capital for the manufacture of an electric type-setting machine.

The city of Lafayette, Ind., is now one of the best lighted towns in the State. Two hundred and one lamps are used, of the Brush system.

The Peru, Ind., Electric Lighting Company filed articles of incorporation with the Secretary of State this week. The capital is placed at $50,000.

I am pleased to bear evidence to the progress that is being made in incandescent lighting in Kansas City and vicinity. Al- of the new office buildings have contracted for plants, and as in cities farther east no building is considered complete without incandescent lights. The energy and push displayed by the agents of the Edison system for that territory—the Western Electric Construction Co.—has conduced largely to this end.

Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes me the following quotations upon telephone stock:

Bell of Mo.	$155@$157
Central Union	48@ 49
Chicago	385@ 400
Colorado	20@ 22
Cumberland	80@ 85
Great Southern	30@ 33
Michigan	76@ 77
Mo. & Kan.	75@ 80
Rocky Mountain Bell	40@ 45
Wisconsin	105@ 107

C. H. M.

CANADIAN NOTES.

TORONTO, July 6, 1887.

Electricity is to play an important part at the combined Dominion and Industrial Exhibition to be held at Toronto from the 5th to the 17th of Sept. next. The railroad connecting the street car terminus with the grounds will be again operated by electricity. The locomotive, designed and constructed under the supervision of Mr. J. J. Wright, manager of the Toronto Electric Light Company, and which did such good service last year, will again be used. Improvements suggested by the experience of former years will be introduced and the generating power increased, so that a speed of at least 40 miles an hour is expected to be attained. High speed is rendered necessary owing to the great number of passengers to be carried in a limited time. The electric engine performs the service in a manner that no other motor could possibly do. Horses are out of the question, and the smoke and dirt of the steam locomotive, on a road of this description, would make it decidedly unpopular

The grounds and buildings will be lighted by 250 arc lights, besides incandescents, furnished by the Toronto Electric Light Company, the Ball Electric Company and the Royal Electric Company, of Montreal. Previous to the advent of electricity as an illuminating agent, the exhibition was essentially a daylight one, the grounds and buildings having to be closed at sundown. At the present time, however, the aspect of affairs is entirely changed. The directors find that the evenings are the most popular, especially with those whose occupations make it inconvenient for them to visit the exhibition in the day time. Some of the best attractions are reserved for the evening, and, indeed, often require the aid of the electric light to properly display them. The spectacular piece, "The Last Days of Pompeii," produced last year, was rendered intensely realistic by the flashes of light from four powerful arcs placed in parabolic reflectors and focussed on the scenery, which, with the performers, extended a distance of a hundred and sixty yards from wing to wing. Another feature of the exhibition, which will be repeated this year, was the illuminated fountain. Three columns of water are arranged to shoot into the air from a rockwork base and are intermingled with hundreds of sprays from revolving sprinklers. Concealed in the rockwork is a chamber for the operators, who are protected from the falling water by glass lenses, opposite to which are placed the electric lights in powerful reflectors, each with a slide in front composed of strips of variously tinted glass. The effect is marvelously beautiful, the columns of water appearing like liquid fire; and the sprays are illuminated with continually changing rainbow hues. The Toronto Electric Light Company have also on the ground a Star iron tower, 125 feet high, which carries twelve 2,000 c. p. lights, and besides casting a brilliant glow over the park below is a conspicuous object for miles around, and can be seen across the lake for a long distance. The main tower of the principal building, composed of glass and iron at an altitude of a hundred and fifty feet, is illuminated by lights in ruby tinted globes. These produce a novel effect through and around the building. Altogether, the use of electricity in its various forms has popularized the exhibition at a time when formerly it was unremunerative, and the directors are to be congratulated on the successful financial result of their enterprise in this respect.

THE TELEGRAPH.

Fire Alarms.—The State Signal and Safety Company, of Chicago, Ill., has been incorporated by J. Gibson and others, with a capital stock of $50,000.

A New York Company.—The Commercial Union Telegraph Company of Albany has increased its capital stock to $200,000, and proposes to extend its lines. Poles will be erected and wires strung from Albany to New York via Chatham, Ghent, Philmont, Millerton and White Plains; also from Albany to New York via Hudson, Poughkeepsie, Peekskill, Tarrytown and Yonkers.

Telegraphs in the West.—The Pacific Mutual Telegraph Company officials at Kansas City have decided to construct a line from Omaha to Sioux City, giving Kansas City direct connection with that point. "Nor is this all the company has in view," said one of the officials of the company. "We are going to begin the construction of the Denver line at once. Every inch of the right of way in Kansas has been condemned, and we are now only waiting for the material. The Pacific Mutual people do not anticipate an easy task in constructing the Denver line. It is generally understood that the condemned right of way lies along the railway line, and to this the Western Union lays sole claim on the strength of contracts entered into with the railway officials, so a war of telegraph companies is on the tapis. "Yes," said another official, "I think the Western Union will contest every inch of ground, and cut wires wherever they are put up. But, on the other hand, I think the Pacific Mutual has a handful of its own devices, and will get to Denver or bust."

Pledged to the Public.—There is one consideration, says the *Commercial Advertiser*, which weighs against predictions of the absorption of these two rivals by the Western Union. Both Mr. Garrett and Mr. Mackay stand pledged, alike to their stockholders and to the public, not to surrender their property to Mr. Gould. It is difficult to see how any such absorption could take place without gross breach of faith, and these men are not operators who can afford to play fast and loose with their own reputations. But there are other ways to accomplish the "deal" than by actually transferring their properties to the Western Union magnates. A virtual transfer of control may easily be made, whereby rates on the rival telegraph line shall be advanced to the Western Union scale, and this merely on the alleged ground of expediency. Regarding the cable company, the Commercial has always offered to co-operate with the Western Union for an advance of rates to forty cents a word, and it may be this which is in progress. Any further advance than this would be in flagrant violation of the promise made to the public in the Commercial Company's circular of April, 1886.

THE TELEPHONE.

Massachusetts.—The Boston *Journal* says the New England Telephone Company is setting poles for a 100-wire service on the Central Massachusetts road to Northampton.

Acoustic Patents.—The Lord Acoustic Telephone Manufacturing Company has purchased a number of acoustic telephone patents—Bennett, Gilliland, Lakin and others, and proposes to push its business.

Paterson, N. J.—There is in Paterson a person named George Addy, who is of a remarkably vandalistic turn of mind. He has recently been engaged in a most vigorous warfare on the wires. He is not merely satisfied with cutting wires, but last week found a lineman up a pole, and proceeded to chop the pole down with the man on it. When he is not engaged chopping poles he is busy cutting wires with garden shears, bringing the wires within reach by means of a cord to which a weight is attached. He is quite impartial as to the wires he cuts, and distributes his attentions equally among telephone, telegraph, electric light, burglar alarm, and fire telegraph wires. It is needless to add that the telephone company has engaged counsel, and appealed to the law. Addy says that does not scare him, and that he is determined to keep wires away from his house.

THE ELECTRIC LIGHT.

Salt Springs, Ga.—The Salt Springs Company has put in an electric light plant.

St. Cloud, Minn., is to have a plant put in by the St. Cloud Water and Power Company.

Quincy, Mass.—Durgin & Merrill propose, it is said, to put up an electric light plant at Quincy.

Randleman, N. C.—The Randleman Manufacturing Company will put an electric light plant in its cotton mill.

Tuscaloosa, Ala.—The Tuscaloosa Coal, Iron and Land Company will proceed at once, it is said, to put in its proposed electric light plant.

Canton, N. Y.—A 70 h. p. engine, by Taylor, of Chambersburg, Pa., has been received for the electric light plant and is being installed.

Columbus, O.—The new Edison station at Columbus is to cost $15,000 it is said. Work in connection with the whole installation is being rapidly pushed ahead.

Brunswick, Germany.—The municipal authorities of Brunswick are inviting tenders for the construction of a central station to furnish light and current for the inhabitants.

Houlton, Me.—The plant at Houlton, Me., is to start at once, furnishing both arc and incandescent light. The station is at the pumping-house of the Houlton Water Company.

Hyde Park, Chicago.—The Hyde Park Electric Light Company was incorporated last week by H. Hoffman, L. Schwachow and G. W. W. Carroll, with a capital stock of $250,000.

Huntsville, Ala.—The Huntsville Electric Light Company is about to start up its plant. The Huntsville Light Company has also obtained right of way, and proposes to put in a plant. Mr R. E. Coxe is its president.

Le Mans, France.—More than one gas company in Europe is now going into the supply of the electric light. Among the latest converts is the Gas Light Company at Le Mans, France, which is preparing to furnish electric light from a central station

Mulhouse, Germany.—Siemens & Halske have recently made a contract with the town of Mulhouse, under which the firm engages to supply electric lights, and to pay a fixed percentage of profits to the local authorities, whenever said profits exceed a certain figure.

Harrisburg, Pa.—Mr. Spang, of the Ball Company, has just started up an arc light plant on a mountain overlooking the city. During the day the machine—of the Ball type—is used for charging 124 storage cells, which are employed at night in running incandescent lamps. The plant is a success electrically.

New Rochelle, N. Y.—Mr. Adrian Iselin has notified the American company which is lighting the streets of New Rochelle to remove its poles from Davenport avenue, as it is private property. The people of New Rochelle are very much concerned about this, as if the poles are removed it will cost considerably more to light Hudson Park. The light is very popular in New Rochelle.

Hastings, England.—The Hastings Electric Light Company, it is interesting to know, has just issued its fifth annual report—a thing few other lighting companies in England have succeeded in doing. The company's business shows a steady growth. It now has on three circuits 30 arcs and 704 incandescents. The company proposes to extend its business by raising $25,000 on debentures.

New Orleans.—Owing to a very bad fire in the Werlein Hall, adjacent to its station, the Edison Company had to shut down for an hour or two on July 1. Several of the circuits were damaged, but the service was in full operation the next night. The station itself escaped serious injury, although the heat drove the workmen from the building. The promptitude with which business was resumed is noteworthy.

Riverside Drive, New York.—It is proposed to light this magnificent drive along the Hudson River by electricity. Gas is objected to because it injures the trees, and because an extension of the service would require the roadway to be broken up for pipe laying. The drive has become very popular lately and the necessity of better light is very apparent. It is probable that electric lights will be put in shortly.

Austin, Tex.—The Austin Electric Light Company, with a plant of 110 Brush lights of 2,000 c. p, has consolidated with the City Water Company, and, as stated in this column last week, the new organization will be known as the Austin Water, Light and Power Company. Contracts have been made with the Westinghouse Company for the supply of three 1,300 light machines and four 80 h. p. boilers. The additional plant will be installed immediately.

Winnipeg, Man.—The Manitoba Electric and Gas Light Company, of Winnipeg, W. Bathgate manager, bought out the Northwest Electric Light Company last fall and has been running the plant all the winter and spring at the old station. It is now putting up a new station at the gas-works, installing a new 150 horse-power compound surface condensing engine and two steel boilers, and expecting to go very shortly into the supply of incandescent lights and motors.

Florence Iron Mine, Wis.—The Florence Mining Company are not increasing their plant, as has been stated. They have now had their Brush plant in use for five years. It consists of a No. 6 Brush dynamo and a 6×12 Straight Line engine. At present nine lamps are in service. It is interesting to learn that the company are not now using the lights underground, as they have found that in their case the maintenance of the line involved too much work. It seems possible, however, that the troubles encountered may be remedied. The lights in use are distributed over the different parts of the surface works.

Owen Sound, Can.—Eleven months ago an arc plant of 30 lights of 2000 candle-power was put in operation on a circuit of four miles. At the present time no fewer than 80 arc lights are in service on a 12 mile circuit. It is claimed that no other town in the dominion can boast of as large a plant as this for the same population. The Owen Sound Electric Illuminating and Manufacturing Company is so well pleased with its success that it is now going into the incandescent business. It is in receipt of its first installment of a 500 light incandescent plant, and will have the system in operation by August 1st. Mr. Parker, the manager of the company, is entitled to congratulations.

The National Electric Headlight Company, of Cincinnati, was recently organized with a capital stock of $650,000, and owns about 20 patents, including those of Mr. George Pyle, on dynamos, lamps and engines for train headlights. The company has made a contract with Post & Co., to manufacture and put on the market its electric headlights at once. They have now been used on the C., A. & C. R. R. for over two years, and practical electricians and railroad men report themselves as satisfied with the commercial results. Frequent tests show that with these headlights as many as 22 to 68 headlights can be counted from the engine cab, or as far as an engineer can see clearly in the day time. It is to be hoped that the headlight, now in good hands, will come into general use.

APPLICATIONS OF POWER.

A Sprague Car, for Boston, equipped with Electrical Accumulator batteries, is now being built at the Sprague factory as quickly as possible.

The Short-Nesmith Series System will, it is reported, soon be put in by some of the street railways, in conjunction with motors of the Cleveland Company.

Lima, O.—The Van Depoele road has gone into operation at Lima, O., with four cars, very successfully. On July 4 the cars averaged over $100 apiece in fares.

Dayton, O.—The Van Depoele Company have made a contract to build an electric railway at Dayton. Nine cars will be

required. The conductors will be partly overhead and partly in a conduit.

Binghamton, N. Y.—The Van Depoele road is reported to be in excellent working order and to be giving good service. It has now been running several weeks.

San Antonio, Tex.—Mr. R. Woolley, Jr., of Cincinnati, represents a company formed there to build an electric railway at San Antonio, Tex. This road will, it is said, be about five to six miles long.

Jersey City.—It is reported that the Jersey City & Bergen Railroad is about to begin operating by electricity, using storage batteries and motors of the form devised by a Mr. J. Weiss, of Jersey City.

A Company that Gets Up Early.—The Van Depoele Company has the honor of being the first to put electric street railways in practical commercial operation in the States of New York, Pennsylvania, Ohio, Michigan, Wisconsin and Alabama.

Overhead Service.—A new company is being organized in Pittsburgh for the purpose of holding and selling patent rights for electric railway purposes. It is to be called the Overhead Conductor Electric Railway Company, and has a capital stock of $300,000. Among those interested in it are George Westinghouse, Jr., John Caldwell, H. H. Westinghouse, Frank L. Pope and Thomas B. Kerr. The company's conductors, instead of being under ground, are to be overhead like telegraph wires. The Observatory Hill electric road and the Mount Oliver electric road will, it is said, operate the patents of this company. It is claimed that this method of conductors is a signal advantage over the underground method, as it preserves them much longer.—*Iron Age.*

The Liability to "Slip."—In a letter to the New York *Times*, Mr. J. B. Vroom, of Denver, says: "I notice that a street car company expect to use an electric storage battery on Fulton street as a motor. The great difficulty in operating any system that involves driving wheels is the liability to slip during freezing weather, the weight of the load over them not being sufficient, generally, to crush through the ice to the rough surface of the rail. That has been a source of great annoyance here. Even 'sanding' did not remedy the trouble, and, in comparison with New York, we have little or no snow or rain. Although our cars are run from a central station (and not storage batteries carried upon the cars), yet the power is communicated to 'driving wheels,' and in that regard the principles are similar. I predict that in your city, where there is so much moisture, the conditions that I have mentioned will not only prove an annoyance, but an almost insuperable obstacle." Mr. Vroom's "facts" and fears are wrong but the point he calls attention to is an interesting one.

MISCELLANEOUS NOTES.

A Portrait of Faraday, excellently done, was given with a recent issue of the London *Electrician*.

Shocking an Elephant.—The great elephant "Chief," who forms a part of the "pageant of victory" in the play "Fall of Babylon," met with a curious misfortune last week. Just as he was about to go on the stage the company was startled with a tremendous roar and the great elephant fell to the stage writhing in pain. It was discovered that he had been engaged in scientific investigations and had seized an electric light wire with his trunk. He received a severe shock, and his trunk was considerably burned, but he was not otherwise injured.

PERSONALS.

Prof. H. A. Rowland, of Johns Hopkins University, will, it is reported, shortly take a trip to Europe.

Mr. T. O. Callender, manager of the Callender Company, in London, is now on a visit to this country, having arrived per steamer "Servia." He will be here for a month. One object of his trip is to make a study of electric lighting methods. Mr. Callender is also interested in a new system of long-distance rapid underground telegraphy, on which some remarkable reports have been made.

Mr. Gardiner C. Sims, of the Armington & Sims Engine Company, was married recently to Miss Laura Brayton, a near relative of Mr. H. N. Fenner, of the New England Butt Company, of Providence. The marriage took place at Providence, and we understand that the honeymoon was spent at Long Beach. Mr. Sims is very widely known and popular among electricians, and is receiving their hearty congratulations and good wishes.

Mr. William Maver, Jr., has just been gazetted as the Electrician of the Baltimore & Ohio Telegraph Company, vice Mr. H. Van Hoevenbergh, resigned. Mr. Maver's promotion from assistant electrician is richly deserved, and is another exemplification of the quickness with which Mr. Bates recognizes merit, and then, as opportunity offers, rewards it. Mr. Maver is an accomplished telegraph electrician, as his well-known book on the quadruplex testifies, and he is, moreover, well abreast of all the latest electrical work. He is still young, and has a career of distinction before him.

Prof. Tyndall.—A banquet was given to Prof. Tyndall on June 29, on his retirement from the chair of Natural Philosophy in the Royal Institution. The banquet was held at Willis' Rooms, London, under the presidency of Prof. Stokes, "and was attended by a company which, in intellectual measure, was probably as distinguished as any of the same size ever addressed by man." In his speech, Prof. Tyndall called special attention to the work of Faraday.

Mr. C. R. Heap, of London, was in New York last week, making arrangements for the introduction of the American system in England and on the Continent upon a large scale. Mr. Heap is an American, whose keenness and push several years of foreign residence have failed to diminish.

Mr. W. J. Jenks, of the parent Edison Company, was interviewed recently at Brockton, Mass., and brought out the interesting fact that Mr. F. J. Sprague built there the first model of his motor, now so widely known, while engaged as engineer in installing the Brockton Edison plant, "the carpet and furniture being frequently decorated with iron magnets, armature cores, spools of wire, bottles of japan, asphaltum, varnish, shellac, machine oil, etc."

BUSINESS NOTICES.

Jordan & Gottfried, 208 Canal St., N. Y., carry a complete stock of iron and brass machine and wood screws, bolts, cap and set screws, taps, dies, files, twist drills, brass and rubber in tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

STOCK QUOTATIONS.

The following list, compiled by Mr. W. H. Baker, member New York Stock Exchange, 16 and 18 Broad street, gives the current quotations of electrical stocks:

July 12, 1887.

TELEGRAPH.	Bid.	Asked.
Am. Dist.	25	35
Am. Tel. & Cable	75	76
Cen. & So. Am.	95	110
*Com. Tel	100	103
*Gold & Stock	.....	.....
*Inter. Ocean Tel.	.....	.....
N. Y. Mutual	76	80
Pac. & Atl.	45	55
*Postal T. & C.	30	35
South. & Atl.	70	78
W. U. Tel.	76⅛	76¼
W. U. Scrip	74	.....
W. U. Bonds	117	.....
Mut. U. Bonds	86	86¼
TELEPHONE.		
Am. Bell	220	221
Am. Speaking	110	115
Erie	33	33½
*Hudson River	.....	60

TELEPHONE.	Bid.	Asked.
Mexican	1	1¼
*N. Y. & N. J.	87	92
N. Y. & Pa.	.....	.....
New England	43	45
*Southern Bell	125	135
ELECTRIC LIGHT.		
*Am. Electric	.....	.....
*Brush	.....	.....
*Brush Ill.	90	100
*Consolidated	.....	.....
*Daft	.....	.....
*Edison	220	225
*Edison Ill	95	100
*Edison Isolated	.....	.....
*United States	40	50
*U. S. Ill.	90	95
MOTOR.		
*Daft	.....	.....
*Sprague	.....	.....

* These stocks are so seldom dealt in that it is difficult to give prices at which they can be bought or sold. The figures given are as near as can be ascertained.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS DATED JUNE 28, 1887.

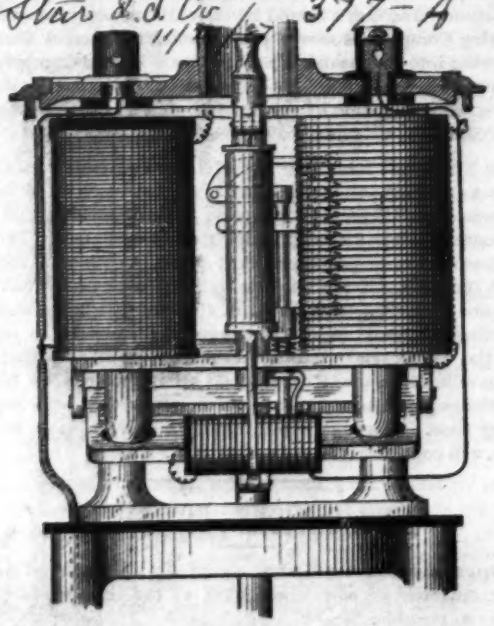
365,365. Signal Box; F. W. Cole, Newton, Mass., Assignor to the Gamewell Fire Alarm Telegraph, of New York, N. Y. Application filed Jan. 22, 1887. An improvement on the apparatus set forth in patents 223,218 and 232,343.

365,384. Incandescent Electric Lamp; P. O. Jenkins, Washington, D. C. Application filed July 23, 1886. The casing of the lamp is mica. The carbon electrode is reduced in diameter between its extremities, and is inclosed in a casing of graphite or similar substance, the latter being supported in soapstone posts or supports.

365,414. Hanger for Electric Lamps; F. Thomson, Montreal, Quebec, Canada. Application filed Feb. 19, 1887. An extension bracket swings horizontally on a pivot, and carries the lamp on one end and a counterpoise on the other.

365,438. Thermostat; H. E. Jacobs, Milwaukee, Wis. Application filed March 1, 1887. An electro-magnet is adjustably supported adjacent to a thermostatic bar, and an armature is carried by the bar.

365,460. Electric Lighting of Railway Cars; C. E. Buell, Springfield, Mass. Application filed Feb. 19, 1886. The



365,553. ELECTRIC ARC LAMP.

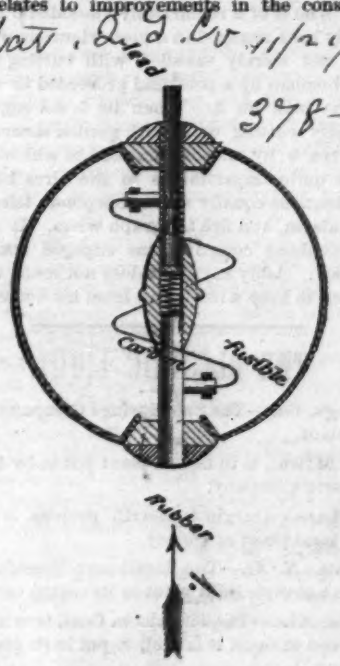
invention consists broadly in the combination with a railway car and with electric lamps supported from the roof or sides thereof, of a battery placed beneath the floor of the car and switch mechanism for connecting up the lamps and batteries.

365,493. Electric Alarm Clock; M. Stecher, Philadelphia, Pa., Assignor of one-half to Charles Wiegmann, same place. Application filed March 18, 1887. The invention relates to details of construction.

365,495. Incandescent Electric Lamp; E. P. Thompson, Elizabeth, N. J. Application filed Sept. 15, 1886. For description see page 26, this issue.

365,498. Globe for Electric Lamps; G. L. Abbott, Corning, N. Y. Application filed July 2, 1886. The globe is formed of vertical segments of glass or similiar material. The segments are screw-threaded and set into a screw-threaded ring.

365,499. Incandescent Electric Lamp; C. G. Anderson, Hartford, Conn. Application filed Nov. 15, 1886. The invention relates to improvements in the construction of the



365,499. INCANDESCENT ELECTRIC LAMP.

bulb, whereby the air may be exhausted therefrom and the bulb sealed up without melting the glass, thus dispensing with the services of a glass blower for inserting and attaching the incandescing filament. The invention also provides means for forming a circuit around the lamp when the filament breaks. See illustration.

365,509. Filament for Incandescent Electric Lamps; T. A. Edison, Menlo Park, New Jersey. Assignor to the Edison Electric Light Co., of New York, N. Y. Application filed Aug. 7, 1882. The filament is formed of carbonized oxidized drying oil.

365,525. Mechanical Telephone; J. Lauhoff, Detroit, Mich. Application filed Aug. 21, 1886. The invention relates to structural details, with a view to simplicity.

365,543. Electric Arc Lamp; E. Thomson, Lynn, Mass., Assignor to the Thomson-Houston Electric Co., of Conn. Application filed Sept. 10, 1884. The objects are economy and durability. A detachable ring forms the periphery of the top or closing plate of an arc lamp and carries a dependent casing or boxing. A polarized magnet is located with one end toward the pole of the main magnet and the other toward the pole of the derived circuit magnet.

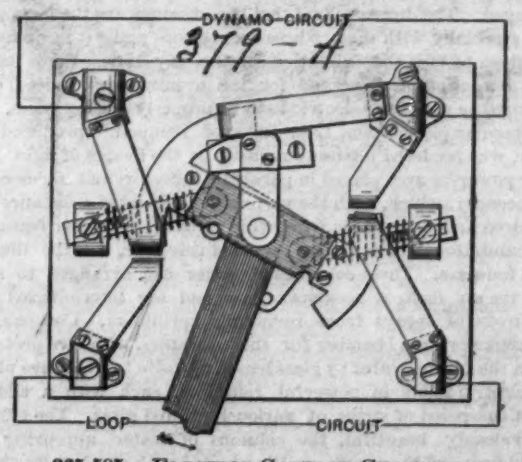
365,585. Electrical Contact-Changer; D. Davis, Jr., Boston, Mass. Application filed Nov. 22, 1884. The apparatus is especially adapted to serve the purpose of cutting out a loop. The construction is shown in the illustration.

365,600. Electric Temperature-Controlling Device; H. E. Jacobs, Milwaukee, Wis. Application filed March 1, 1887. The regulating device is connected directly with the valve, damper or shutter to be operated, and is controlled by the operation of a thermostat located in the room where temperature is to be regulated.

365,639. Fire Extinguisher; C. H. Shaffer, Rockford, Ill.; Assignor of one-half to Jones, Woodruff & Co., of same place. Application filed Sept. 25, 1886. An open electric circuit is employed, which, on being closed by an excess of heat, as in case of fire, actuates one or more electro magnets for opening one or more valves, and thus letting on water for extinguishing the fire. An alarm is also sounded.

365,705. Printing Telegraph; G. B. Scott, Brooklyn, N. Y., Assignor to the Western Union Telegraph Company, of New York. Application filed Feb. 28, 1887. The improvements relate to the apparatus for causing the usual simultaneous interruptions of printing telegraph circuits for the prevention of sparking when the poles are changed. The invention also includes a novel safety cut-out.

365,726. Electric Circuit Testing Apparatus; G. F. Bulen, of Jersey City, N. J. Application filed July 8, 1886. The objects of the invention are to provide apparatus whereby the lines, instruments, batteries, and the usual adjuncts of a



365,585. ELECTRIC CONTACT CHANGER.

fire alarm, burglar alarm, or other electric system may be automatically tested at predetermined intervals, and whereby any defects therein may be automatically detected and the fact signaled to an operator at a central office.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patent issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.

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NEW YORK, JULY 16, 1887.

ON this and the succeeding pages will be found a series of articles on electricity and its applications. Not only are lamps, motors and other apparatus illustrated, but interesting information is given as to the method of their manufacture. There is still much to be learned about electricity, but what is known of its principles already serves as a foundation for some of the largest and most scientific industries in the world. The great fact is, as these pages show, that through the agency of the modern "central station," the use of electrical current and apparatus is now made easy and cheap to everybody; and hence there is no reason why every inhabitant in Kansas City should not enjoy the most advanced conveniences that the highest electrical skill and genius of the age secures.

THE general activity in the electric light field continues to excite comment. The installation or ordering of new plants has hitherto slackened about May, but this year there has been little falling off, and the indications are that the fall season will be remarkably brisk. The fact is that the mere work of equipping new buildings and factories is alone sufficient to occupy the time and energies of a very large proportion of those engaged in the business; while outside that department is the central station work, in which, despite the prophecies that were freely made not long ago as to coming dullness, the growth was never equaled. Some of the largest central stations ever planned, arc or incandescent, are now under contract or in course of construction.

THE electric motor is already bringing to the poor car horse a welcome surcease from suffering, and thus once again we find electricity enlisted in the work of ameliorating the condition of animals. Some idea of the awful waste of life and energy on a horse-car line in summer may be gained from the figures given elsewhere in our columns as to the Belt Line, New York. The tender-footed green horses put on to replace those killed by the fire have been dying off by the score. On the Broadway road, it appears from statistics recently obtained that the horses only make 9 miles a day and require an hour and forty minutes to do it. On the Eighth avenue road, 12 miles constitutes a day's work for a team. This is not heavy work, but in spite of the care taken by the various companies, the horses even now show signs of pitiable distress far too often, and as the summer advances their physical state is still more sadly reduced.

AN interesting article will be found on another page describing what has been done by Mr. E. H. Johnson, president of the Edison Company, in fitting up his country residence at Greenwich, Conn., with electrical apparatus. The installation is without an exact parallel either at home or abroad, presenting as it does many unique features, especially in the utilization of electric motors and in the arrangements for lighting and heating. In fact, the devices recall by their novelty and originality what was attempted by the celebrated conjurer Houdin, according to the accounts given of his Priory at St. Jervais; and yet there is nothing in the plant that is not within the compass of liberal and judicious outlay, backed by ingenuity. We do not intend to disparage the results achieved when we say that it would be difficult to give a reason why an installation of this kind should not be enjoyed by all possessing the income adequate to maintain such an establishment; and in view of the pleasure and convenience afforded, the expense of the electrical outfit is after all comparatively small. One would not have to go far to find country houses that have cost two or three hundred thousand dollars and that are wanting in every one of the improvements our article enumerates. Now that the example has been set in so spirited and successful a manner, we hope to see other country mansions equipped in this way. Installations of a somewhat similar nature, though far less extensive and striking, are not so very rare in Europe. Thus, in England alone, may be named the plants of Sir David Salomons, Lord Armstrong and the Marquis of Salisbury. The last of these, we believe, comes nearest that at Greenwich in its variety and completeness. It seems to us impossible for any one to visit the house now described without wanting to enjoy its many scientific luxuries, and it is one of the likeliest things in the world that Mr. Johnson may be setting a new and permanent fashion for American millionaires.

The New Light.

BY E. R. WEEKS.

The present century has witnessed the introduction of three illuminants, gas, petroleum, and electricity. Gas and petroleum were not slow in displacing the dip and candle; but the rapidity with which electric light has gained a firm foothold, and its manufacture become an established industry, is phenomenal.

It was first known as a commercial product in 1879, yet the present capital invested in its manufacture in the United States alone is over one hundred and fifty million dollars. In New York City, more than thirty miles of streets and forty acres of parks are now lighted electrically, and the council has passed a resolution instructing the gas commission to place two thousand additional arc lamps in parks, and on streets and avenues between the Battery and 125th street. Other cities are doing much in the same direction. Even far away Cheyenne has adopted the new light, and is making one of the most extensive experiments in domestic lighting by means of storage batteries that has yet been undertaken.

There is scarcely a manufacturing interest that has not felt the impulse given by the discovery of an illuminant offering opportunity for such perfect inspection. Before the introduction of electricity into woolen mills, the cloth produced in winter was inferior to that manufactured in summer. By means of the new light, this inferiority is fast disappearing.

Although electric light as an article of commerce dates within a decade, the principles upon which its production is based have been familiar to the world since the time of Sir Humphrey Davy. It was then discovered that it was possible to render a carbon pencil or platinum wire luminous by forcing through it a current of proper quantity; and also that if the poles of a battery be near together, and if the difference in their potential be sufficient, electricity will leap from one to the other, giving off a trail of light as it passes through the dividing space. All the real progress made since that time has been in the invention of appliances for generating economically a uniform and well-regulated current, and for utilizing the trail of light—the spark, or arc.

All arc lights are practically produced by forcing a current of electricity through two rods of carbon usually placed in one right line. The current generated in the dynamo being once established in the circuit of which the lamp forms a portion, the carbon points are maintained at a constant distance apart, and the electricity in passing this gap draws an arc of light. The fact that its spectrum is nearly the same as that of the sun's ray renders the arc light desirable for stores and factories where it is necessary to distinguish delicate colors.

The incandescent light works on a somewhat different principle. A bulb of delicate glass usually resembling a pendent soap bubble, has a loop of carbon inserted in its cavity which is exhausted of air and hermetically sealed. By means of the line each end of the carbon filament is connected with a pole of the dynamo, and as it is traversed by the current, its temperature is raised to that of a white heat. Hence the name "incandescent"—*glowing with white heat.* The light here comes from the carbon itself instead of from the space between two points. This dainty little bulb gives the ideal artificial light—a clear, soft glow without flicker or unsteadiness, and lending itself to decorative purposes readily and safely. Draperies are in no danger from a wavering flame played upon by every wandering breeze. With proper precautions, these lamps may be placed in show cases; laces can be thrown over them, they may be covered by scarfs, without the least danger from fire. Should the glass be broken, the thread of carbon would be instantly destroyed, the current as instantly shut off, and the light extinguished.

One of the special characteristics of the electric light is its wide range of power, which renders it adaptable to every requirement of illumination. The powerful arc lamp, suitable for streets, large rooms, light-houses and other places requiring great intensity, has produced a light equal to that of eight hundred thousand candles, while the incandescent lamp will give the merest speck of brilliant light, which may illuminate the throat, or tooth, or assist at the renovation of a diseased hip bone, the whole lamp being of such minute construction that it is no larger than a pea.

Again, wires may be so placed that the lamp can be moved to any part of the room more easily than one could move a common lamp, and with absolute safety. As the glass bulb of the incandescent lamp can be fixed in any position and at any angle, there need be no intervention of a receptacle or holder which would cut off a great portion of the light and prevent its equal and most efficient distribution. It will be readily seen that in many of the fine arts, such as carving, designing and engraving, where a small quantity of brilliant light must be thrown upon a piece of work, these last two qualities will have great value.

From many points of view the new light is a most desirable addition to modern conveniences. On receiving gas the world rejoiced that it was relieved of so much unpleasant and time-consuming work; but the facility with which the electric current is turned on or off by the turning of a screw, renders it far superior in this respect, while in dispensing with matches and an open flame, it greatly reduces the danger of fire. Moreover, this light is absolutely healthful, emitting no smell, consuming no oxygen and giving off no appreciable heat. An eminent New York oculist, who has made a special study of the effect upon the eye of various kinds of artificial light, finds that electricity is the least hurtful. "Its light is absolutely steady, and it produces the maximum illumination with the minimum heat. Out of the eleven hundred persons examined who work under the incandescent light, no case of injury to the eye was found; in fact, those who had formerly suffered from errors of refraction claimed that their sight was improved." The value of these qualities in a thing of such constant use as is artificial light, needs no explanation. When we consider the fact that the preservation of books and paintings requires pure air, the need in our homes, libraries and art galleries of an illuminant which does not vitiate the atmosphere becomes still more apparent.

As a moral force, electricity has proved an invaluable agent in maintaining order and preventing crime. When streets were first lighted, crimes immediately decreased in number. As methods of illumination improved, this decrease became greater and greater, until its maximum has been reached by the use of the powerful arc. The most dangerous and abandoned sections in many of our great cities have been rendered safe and comparatively pure by means of this light. "In preserving the peace and safety of our citizens," says a leading New York paper, "it is second only to the most efficient police force."

This light is largely used in railroad yards, and it is to be hoped that the experiments now being made by several railroad companies will demonstrate the practicability of lighting passenger coaches by electricity. Most of the loss of life in case of a wrecked train results from fire that originates in broken lamps and overturned stoves. The new light will do away with one of these causes; and, should the prophesies of enthusiastic believers in electricity be realized, this force as a heater will remove the other cause.

Although not as yet extensively employed in photography, it has been practically demonstrated that for this purpose it equals day light, and is a much more reliable illuminant, while it doubles the hours of service.

Perhaps one of its most gratifying applications may be seen in the lighting of mines, where it greatly reduces the danger of explosions. Legislation requiring its use in all mines cannot be long deferred.

Its value in navigation was early recognized, and it is now employed on many of the larger vessels instead of candles and the dangerous inflammable oils which have so frequently caused that most dreaded calamity—a fire at sea. Its success in dock yards and light-houses, for signals and submarine work, has fully demonstrated its adaptability in these directions. Arrangements have just been carried out for lighting the Suez Canal, which is equivalent to doubling its capacity.

The cost per lamp is now greater than that of any other illuminant; but in proportion to the work accomplished, the arc light is by far the cheapest. Incandescent light from central stations can never be so cheap as

gas, for there is no residue from its manufacture that can be made to augment the revenue, as is the case with the latter. The cost of distributing the incandescent current has been so great hitherto as to render domestic lighting from central stations impracticable. Most of this work has been done by means of apparatus in dwellings or neighborhoods, as light can be thus produced at comparatively small expense. The conditions are changing, however.

It is claimed that the whole question of cheap, safe and healthful domestic lighting will be solved by a system wherein high tension alternating currents, which can be run great distances and are not safe for residences, may be converted at convenient points into low tension currents that can be run only short distances, but are perfectly safe. The patents recently granted promise much, but their commercial success is chiefly to be achieved. It is probable that domestic lighting will eventually depend for its electricity either upon these secondary currents, or upon storage batteries charged at intervals from central stations. Lamps are even now being run by electricity generated weeks before it is used. Depreciation of storing power is the chief defect in the present batteries. When a durable and economic system of storage, corresponding to the gasometer, is invented, the lighting of dwellings will become a simple matter. House-holders will then have their batteries refilled at intervals with electricity, as they once filled their oil cans. But until such time as we have learned to "bottle up lightning" *securely* and *economically*, they must manufacture their own. The cost of putting in a house the apparatus for incandescent lighting is not much greater than the expense for gas fitting. The entire plant consists of similar fixtures, lamps, wires and dynamo, and some power by which to run the latter. If the dwelling were near the line of an arc circuit, current sufficient to run a small motor could be had at a reasonable rental. Some country houses might utilize water power, or these two failing, a coal-oil or gas engine of two or three horse power would occupy little space, and would run automatically with perfect safety. As the machinery requires no technical skill and little attention after it is once placed, the general adoption of this form of lighting for the better class of residences can be only a matter of time. Some private houses have installations of this kind which have given entire satisfaction. Many have been deterred from using the electric light in their homes through an idea that it would be a constant menace to life and property. The truth is that when properly installed, the incandescent light is absolutely safe.

Electric light must be regarded as one of the world's conveniences, and like all conveniences, it yields to labor another industry—an industry that requires intelligence and judgment. It is a fact, that electrical employés as a class are superior in this respect to the operatives in other trades. In most of the latter, the best has been attained, but in electricity there is an ever widening field of investigation, that spurs the humblest worker. Every department of this business needs intelligence. Skilled electrical engineers are scarce. But the profession offers inducements in a financial way that may well tempt those who hesitate to enter the so-called learned professions, yet shrink from the trades. In fact, this occupation holds a position between the two—an occupation in which one can never feel that a good education is wasted, yet one wherein the extreme collegiate course is not needed. It is a field in which distinction is yet to be won, and the young man who has a strong bent for mechanics and natural science and can train his mind to grasp details, with their groupings into wholes, will be the future electrical engineer.

Most inventions of great commercial value in mechanics supplant some form of industry, and often throw many out of employment and render worthless a large amount of costly apparatus. The gas interest has felt that the electric light was such an invader, but this is not the case. It is a fact growing into general recognition, that while gas may lose its position as the leading illuminant, it will be the fuel of the future.

The Possibilities of Electricity.

BY T. C. MARTIN.

If one sat down to sketch even in barest outline the future that electricity has in store for us, when all its applications shall have been found, it might be a work to which the most vivid imagination were inadequate. As Dr. Priestley reflected a hundred years ago: "It may be said that there is a *ne plus ultra* in everything, and therefore in electricity. It is true, but what reason is there to think we have arrived at it?" Priestley was of those who were permitted to see the Promised Land, but did not enter. To-day, the evidence of what has been achieved tells us that the greater still lies before. The electrician has gained a foothold on the Atlantic seaboard of his new Continent, and subduing a wilderness of theory, speculation and doubt has already secured some of the fairest provinces that ever rewarded the industry and genius of man. But beyond him lie the crests of distant Alleghanies, and they who have penetrated the further valleys, tell of towering Rockies and mighty rivers to the west and there is whisper of yet remoter mountains of discovery near the setting sun, and of a broad ocean rolling to the world's ultimate confines. And while there is the onward movement for the pre-emption and occupancy of virgin soil, there is going on an equal development in the fields already won, invention being heaped on invention, and improvement added to improvement. The future is to yield to the electrician the navigation of the ambient air and the exploration of the deepest sea. It promises him the production of electric current directly from sunshine, coal and the coarsest fuel. It brings to him the art of instantaneous handwritten correspondence between persons hundreds of miles apart. It points to the time when seeing by electricity will be as much as speaking a matter of every day experience. It will simplify the arts of peace and complicate the artifices of warfare. It holds forth a prophecy of new cures for disease, and of the utilization of faculties for which hitherto the grosser forces of nature have given no exercise. Vague and grandiose as these anticipations are, they will all be realized in measureable degree.

Perhaps one of the best ways of forming an idea of the performance that lies within the present compass of electricity is to take the aerial circuits with which we are all so familiar, and which, when trimly and squarely set up, are far from being the least ornamental feature of a bustling thoroughfare. Time was, and but a few years ago, when the wires were used simply for telegraphic purposes, but the telephone soon came into such popularity and vogue as to relegate the telegraph to a subordinate rank, so far as the multiplicity of circuits is concerned, in large cities and busy centres of population. To-day it is not unusual for as large a proportion as 1 in every 40 or 50 of the inhabitants of a growing American town to enjoy the facilities of telephonic communication, and by means of radiating toll lines to have direct access to any one residing within a distance of a hundred miles. This is in itself a remarkable development, but it has in turn been eclipsed by the vast upgrowth of the electric lighting industry during the present decade. About one thousand electric lighting companies scattered throughout the country, and at least an equal number of isolated plants, now have in operation over 150,000 arc lights and nearly 1,000,000 incandescents. In other words, the "central station" has become as much an element of urban convenience as water-works or a railway depot, and the rate at which many of these stations have grown, doubling and quadrupling their plant almost every year, is not excelled in any other department of industrial or commercial work. Here, however, new considerations have come into play. As in political economy, so in central station work—the question has resolved itself mainly into one of distribution, so that the produce shall reach the consumer with as little loss on the way as possible and in such shape as to be most immediately available for all the variety of purposes that his fancy or need may dictate. At first the central station supplied nothing but lighting apparatus and the current requisite to operate the lamp. It was the severe rule, even within the last year, for one station to furnish only the dazzling arc lights for street purposes and for another to furnish only the little incandescents, whose steadfast and mellow glow is now so cheerful and bright in all the finer new buildings. At the present time, however, the same station will supply either kind of light, or both, on demand. But the greater flexibility and availability of the electric circuit has not stopped at this stage. It has been found that the improvement in the dynamo-electric machine used in the generation of current for lighting purposes has brought with it the higher perfection of the electric motor, which is nothing but a dynamo reversed. The same idea is embodied in the dynamo and the electric motor, and is as simple as all great fundamental principles are. When mechanical power in any form is applied to the dynamo, that power is converted by the rotation of the armature into electric current; and when that electric current is applied to the motor, wherever it may chance to be, the rotatory movement of the armature affords, reversely, a supply of mechanical power. But simple as are the elements and functions involved, it was not until quite recently that the electrician discovered how best to employ them, and hence the development of the motor, though it antedates the electric lamp as an operative device, has been tardy and has but just begun. The great stimulus to its use has been the opportunity presented, as remarked above, by the network of electric wires, ramifying, like a system of nerves, from the station all over the city or district. The humble lineman with his spurs and pliers, has builded better than he knew, and has been the herald of a new era, in which, through the medium of his work, electricity becomes the universal servitor. Instead of being utilized during from three to four hours nightly, these circuits now are employed to transmit all through the day by an agency we can still neither see nor handle, hundreds of horse-power for driving machinery of the most varied nature. Other methods of power transmission are necessarily limited in their work and their range; but the electric wire can be passed through a keyhole, be carried up to the top of a ten-story building, be placed under the floor, be submerged in water, or dropped into the deepest mine, and the current it furnishes will in nowise suffer deterioration or loss such as to interfere with its efficiency.

This fact is still a novelty to the public. The electrician can fairly say, as James Watt said to King George, "I have what all your Majesty's subjects want—power," but the assertion still falls on ears untuned to its meaning and full significance. The householder who turns on the water tap or lights his gas realizes to a certain extent that he is drawing on a reservoir practically inexhaustible, no matter how remote it may be, but he has still to learn that the wire running by his door brings to his service an agent that in readiness and variety of accomplishment is a veritable "Jack of all trades," and whose ability rises in exact proportion to the demand made for performance—whether it be operating a ten mile line of street cars, lighting an exposition building with five thousand lamps, running a churn, rocking a cradle, or curing a headache.

There are some other elements in this new and strange condition of things that deserve a word or two. It may, for example, be pointed out that while the current can be put to a great variety of uses directly, the lamp and the motor for which it is chiefly employed, are of all devices of the kind perhaps the least subject to restriction. Thus an electric lamp will burn in any position that is given it, while an electric motor will run just as well fixed on the ceiling or placed against a door post as when put on the floor. It often happens, too, that power is wanted in a sitting room or parlor quite as much as in a factory or a store, but the trouble has been that the noise and dirt that were admissible in the latter places could not be tolerated in the home. But with the electric motor, power is obtainable with an even æsthetic refinement of cleanliness and without the slightest annoyance from rattling cogs and wheels. The dainty little motor, with its elegant accompaniments and fittings doing its work with precision and accuracy amid ribbons and laces and luxurious furniture is certainly one of the most striking evidences of the supremacy acquired by modern skill and invention over nature's rudest forces. The slightest pressure of a womanly finger on key or button sets the motor in full activity whenever wanted, and as slight a touch stops it. This command of inexhaustible power for household work, in the largest or smallest quantities, and under conditions of the utmost flexibility, is destined to bring about many revolutions and reforms. It is already enabling women to undertake in the privacy of the household work that was before deemed to belong exclusively to the busy mill. It is already relieving many a weary arm and affording new comforts. It bids fair to provide one very practical solution to the vexatious problems connected with the "servant girl" question.

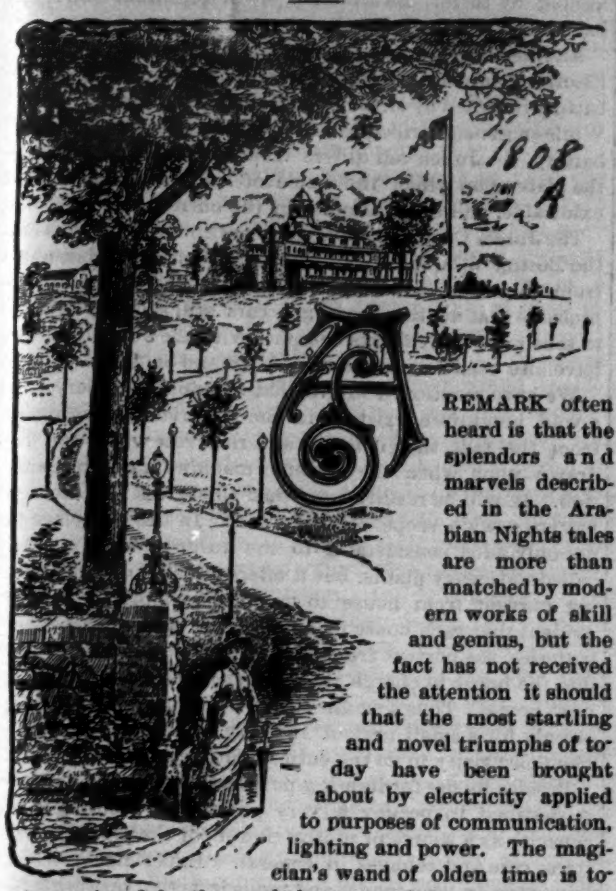
A Simple Form of Electric Pen.

A description is given by Dr. J. Carll in the *Electrician* of a simple way to make an electric pen for multiple copying letters or drawings. A tracing of the drawing to be copied is taken on thin paper, which is then laid upon a piece of common gas carbon. The larger the carbon in proportion to the paper, the less shifting will be required, but a piece of reasonably convenient size may be easily found, and it should be ground to a fair surface. The plate of carbon thus prepared is to be connected with one of the binding posts of a small induction coil, such as that used for an electric bell. The stylus for following the design is nothing more than a lead pencil, rather hard and brought to a fine point. The other end of the lead of the pencil is connected by a wire with the other screw of the induction coil, which in turn is connected with a suitable battery. The wood of the pencil effectually insulates the current from the operator's hand. The arrangement being thus completed, all that is necessary is to follow the design, or to write the letter upon paper resting on the block of carbon, leaning lightly upon the pencil. As the graphite point proceeds, a continuous succession of small sparks flow between it and the carbon, and the intervening paper is accordingly perforated by an infinite number of small holes burned by the sparks. These holes are barely visible to the naked eye except by holding up the paper to the light, but they can be utilized for transferring the design or writing to paper either by dusting on a powder or passing an ink pad over the perforations when laid on the recipient.

Riverside Drive, New York.—It is proposed to light this magnificent drive along the Hudson River by electricity. Gas is objected to because it injures the trees, and because an extension of the service would require the roadway to be broken up for pipe laying. The drive has become very popular lately and the necessity of better light is very apparent. It is probable that electric lights will be put in shortly.

The National Electric Headlight Company, of Cincinnati, was recently organized with a capital stock of $650,000 and owns about 20 patents, including those of Mr. George Pyle on dynamos, lamps and engines for train headlights. The company has made a contract with Post & Co., to manufacture and put on the market its electric headlights at once. They have now been used on the C., A. & C. R. R. for over two years, and practical electricians and railroad men report themselves as satisfied with the commercial results. Frequent tests show that with these headlights as many as 22 to 68 headlights can be counted from the engine cab, or as far as an engineer can see clearly in the day time. It is to be hoped that the headlight, now in good hands, will come into general use.

Electricity in the House Beautiful.



A REMARK often heard is that the splendors and marvels described in the Arabian Nights tales are more than matched by modern works of skill and genius, but the fact has not received the attention it should that the most startling and novel triumphs of today have been brought about by electricity applied to purposes of communication, lighting and power. The magician's wand of olden time is today replaced by the push button and the electric switch, at the mere touch of which night is turned into day, power is transmitted scores of miles, and intercourse is rendered easy between remote places.

These thoughts are naturally awakened when we contemplate what can be done about our own homes by the intelligent application of the devices that lie close at hand, ready for service, and in which the electric current is the prime agent. As an example of the modern use of electricity in domestic employ, the new summer residence of Mr. E. H. Johnson, the president of the Edison Electric Light Company, stands probably without a parallel on this continent. In it, electricity has been put to work of every conceivable nature, and the results obtained must evidently conduce greatly to the comfort and enjoyment of the inmates.

The summer residence of Mr. Johnson is situated on a lofty eminence two and a half miles back from the depot at Greenwich, Conn. It stands in the middle of a lawn of 30 acres, commanding a view of more than fifty miles of Long Island Sound, and is the highest location overlooking the water between Maine and Florida. The house is a large three story structure in the Colonial style, as shown in the little sketch accompanying. It is surrounded by wide porticos which can be illuminated at night with all fancy effects, and is surmounted with a tower which has become a miniature signal service station. At the rear of the mansion is a long row of buildings, commencing with a hard wood finished barn and stalls for fifteen horses, running into a carriage house; a dynamo room, over which are the sleeping apartments for the men; then a boiler room, and ending up with a large bowling alley and billiard room.

The steam plant consists of a 65 h. p. tubular boiler, of the best make, fitted with Jarvis patent furnace, and a new revolving grate bar. The steam piping is fitted up with all the latest improvements, including a grease extractor, and a patent trap for removing the condensed water from the piping. The heating is accomplished by means of a long underground conduit, which, starting out in the open lot back of the boiler room, runs into the cellar of the mansion. Here the conduit ends in a reservoir filled with coils of steam pipe. In winter the air is driven through the conduit and over the coils by means of a Sturtevant blower, operated by an independent Sprague motor, which is situated at the other end. Thus all the air that will be brought to the house is heated before it gets inside the building, and then by a system of independent air passages fitted with electric dampers, which are actuated by thermostats placed in each individual room, the air for each room can be turned off at the entrance of the building independently of all the other rooms. It is thus possible to keep the temperature at exactly 70 degrees during the winter. In the summer it is arranged that all the water which is brought to the place for any purpose passes through the coils situated in this air chamber; cold air is thus forced throughout the house in the same way as the heated air is done in the winter. It is easy therefore to keep the temperature at 75 degrees during the summer months. It is also arranged that either the live steam or exhaust steam can be utilized for heating purposes.

The electric light plant consists of a Straight Line engine 11 × 14, and two No. 10 Edison dynamos of 200 ampères capacity each. There are also two sets of the Electric Accumulator Company's batteries, of 35 ampères each, making 120 cells in all. The accompanying sketch shows the arrangement of the dynamo room.

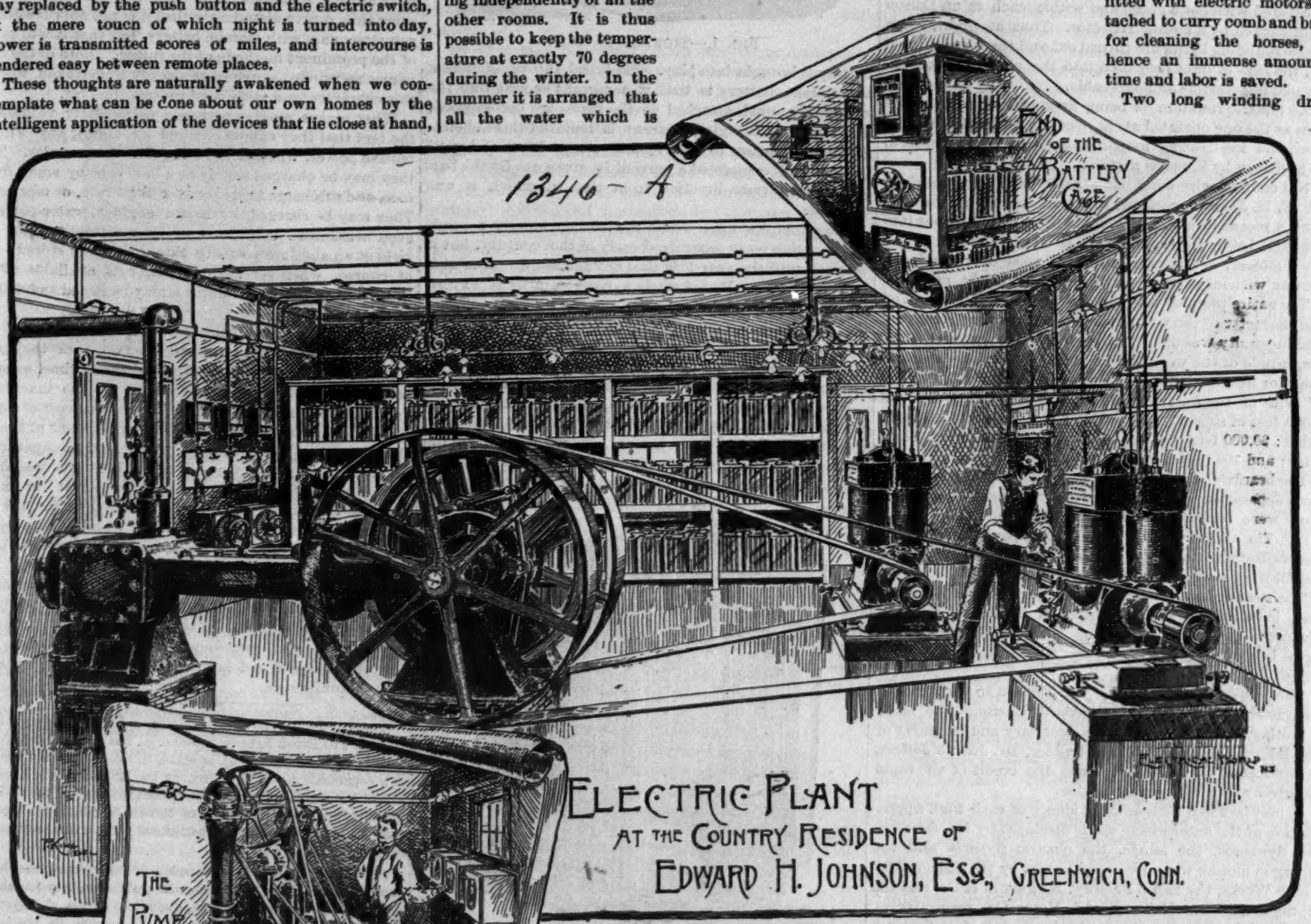
By means of a compound switch, seen on the left-hand wall, either dynamo can be thrown on to the battery circuit, or on to the lamp circuit, or all four can be thrown together. In fact any combination of these four circuits can be made by means of this switch. By means of a galvanometer shown in the sketch, called "end of the battery case," the pressures can be so arranged that when they are thrown together there will be no variation in the candle power. The switch shown on the end of battery case allows for the drop of potential in the battery so that the electromotive force can be kept at a certain pressure for the lamps, irrespective of the amount of current which is coming out of the battery.

The pump room shown in the sketch is situated at the side of the dynamo room and contains the pumps which furnish water for the boiler, the house and barn, and all the other arrangements introduced on the premises. Water is obtained from three wells, one of which is 1,200 and another 700 feet from the house. The pumps, located at the spring, were made by the Hartford Air Pump Company. They operate by air, compressed in the pump-room by means of the compressor pumps shown, each of which is fitted with an independent Sprague motor. There are four different pump circuits going to three different tanks in the house, the two largest of which hold 3,500 gallons each, and the smallest of which is in the laundry for domestic use. These are fitted with automatic floats which open and shut the pump motor circuits, and thus start and stop them automatically. There is also a water tell-tale which is run to the engine room, showing the engineer the exact height of the water in the tanks. The engine and pump-room are fitted up in hard wood with fine oil finish, and all the copper is highly polished and lacquered and all the instruments and dynamos are finished in polished mahogany. The floor is laid in hard wood, and handsome chandeliers adorn the walls.

The barn is finished up in the same style, lighted, of course, with incandescent lamps. The cleaning room is fitted with electric motors attached to curry comb and brush for cleaning the horses, and hence an immense amount of time and labor is saved.

Two long winding drives reach the house, lighted on either side, as shown, by slender lamp posts, each surmounted with an Edison lamp. These circuits are controlled independently from the dynamo room. The gate at the main entrance is fitted with a Sprague motor which can be worked automatically either by the driver, or from the house, and it is arranged so that it will give an alarm at the house whenever the gate is opened. The driveway leads to the house in a large arched entrance, from which hangs a magnificent chandelier. The verandas that extend around the house on both stories are furnished with two circuits, one for lighting purposes, on which each chandelier is represents a piece of large ox-chain, a new and very neat design; while clustered around on all sides are sockets for the insertion of additional lamps for decorative purposes, over 200 of these being on the front of the house.

The main hallway is finished in quartered oak. The ceiling is composed of eight groined arches, each capped with a miniature sun made by Tiffany & Co. Behind these



ELECTRIC PLANT
AT THE COUNTRY RESIDENCE OF
EDWARD H. JOHNSON, ESQ., GREENWICH, CONN.

are Edison lamps, which, reflecting through the different thicknesses of glass, give the well-known outline of a man's face looking from the sun.

The dining room is finished in the same style, with eight handsome chandeliers arranged on different circuits, partially for service and partially for decoration. The parlor is finished in white wood, and the library back of it is finished in rich red cherry.

On the upper floors the rooms are also finished in carved wood of different colors, and the lighting circuits for each floor are brought to a switch-board, which controls that entire floor. There is also a separate independent circuit running through the house called the "pilot light" circuit. This circuit includes one lamp in each room of the house, and can be controlled independently on each floor. At night it can be connected to the burglar alarm, so that, although controllable in other places while the alarm is in its proper position, if the alarm should ring the lights are immediately lighted and cannot be turned off anywhere except at the alarm, which is placed in the proprietor's bedroom. The arrangement is such that the grounds may also be illuminated at the same time.

In a recess in the main hall are arranged a long-distance telephone, and a tele-barometer, tele-thermometer and other registering instruments, furnished by the Telemeter Company, of New York, so that by merely looking at these dials there can be read at a glance the temperature, both indoors and outdoors, the steam pressure on the boilers, the ampères of current flowing out from the different circuits, the velocity of the wind, together with all the other data furnished by a signal service station.

The tennis ground near the mansion is lighted in a novel manner. Here cast-iron boxes, about 6 inches square, are sunk in the earth at short intervals. Each box is covered with plate glass, and within each is an Edison light backed by a strong reflector. Thus at night, when all surrounding lights are turned out and these are thrown on, the rays of light projected into the air will make tennis playing possible and agreeable.

An electric fountain is being arranged for on the same idea as the one operated at St. George, Staten Island, last year, and ice-freezing machines are also being installed, to be driven by Sprague motors.

Not content with what has already been accomplished, Mr. E. H. Johnson proposes to do still more with the current, a recent idea of his, which will probably be put into practice, being the attaching of an electric motor to the lawn mower, so that the attendant need only guide its motion without exerting any pressure upon the machine.

The entire premises are wired for 500 Edison lamps, and the character of the work makes it evident that great care and ingenuity was displayed in their arrangement. The magnitude of the work can be judged when we consider that for its completion there was required over 50,000 feet of wire of the following kinds: 10,000 feet of double and 5,000 feet of single Waring cable; 20,000 feet of Callender cable; 20,000 feet of Grimshaw wire; 3,000 feet of Clark wire; and 100 feet of 20-wire cable.

The beautiful chandeliers and a large part of the accessory apparatus, such as ammeters, voltmeters, switches, etc., were furnished by Messrs. Bergmann & Co., of this city. The arrangement of the motive power and electric generating plant was in charge of Mr. C. L. Edgar, of the engineering staff of the Edison Company.

The steam plant, a model for its purpose, was supplied and installed by Messrs. Potter & Williams, and the elaborate system of wiring by Messrs. Noll Bros., both firms being selected by Mr. Johnson from among the well-known Edison contractors.

The architects employed by Mr. Johnson to carry out his unique ideas were Messrs. Carère & Hastings, the latter a brother of Mr. F. S. Hastings, secretary and treasurer of the Edison Company. To the builder, Mr. Joseph Jeffers, a resident of Greenwich, belongs the credit of the rapid progress made in the construction.

It may be noted that, as an evidence of their high appreciation of the enterprising spirit displayed by Mr. Johnson, the dynamos, the lamps, the electric fixtures and the Sprague motors were presented to him by the Edison Machine Works, the Lamp Factory, Bergmann & Co. and the Sprague Electric Railway and Motor Co., respectively.

We might, in conclusion, note the curious fact that not a single primary battery such as is usually employed in connection with domestic installations—as, for instance, the open circuit batteries for burglar alarm annunciators, etc.—is here to be seen. All the current required is drawn direct from the Edison circuit through the medium of the storage battery.

Telegraphs in the West.—The Pacific Mutual Telegraph Company officials at Kansas City have decided to construct a line from Omaha to Sioux City, giving Kansas City direct connection with that point. "Nor is this all the company has in view," said one of the officials of the company. "We are going to begin the construction of the Denver line at once. Every inch of the right of way in Kansas has been condemned, and we are now only waiting for the material. The Pacific Mutual people do not anticipate an easy task in constructing the Denver line. It is generally understood that the condemned right of way lies along the railway line, and to this the Western Union lays sole claim on the strength of contracts entered into with the railway officials, so a war of telegraph companies is on the tapis. "Yes," said another official, "I think the Western Union will contest every inch of ground, and cut wires wherever they are put up. But, on the other hand, I think the Pacific Mutual has a handful of its own devices, and will get to Denver or bust."

The Electrical Storage Battery.

It is now five years since the storage battery, or electrical accumulator, as it is called, was first prominently brought before the public as an apparatus which, in connection with existing electric light and power plants, fills a want as a reservoir of current. By means of the storage battery electricity is, so to speak, stored up, and in such a manner that it can be drawn upon at any time for use. Thus, for instance, if a dynamo machine has no lighting work to perform in the day time, it may be kept running to charge accumulators, and these may in the night time be drawn upon to furnish current for the electric lights.

This is the general idea of one way in which the storage

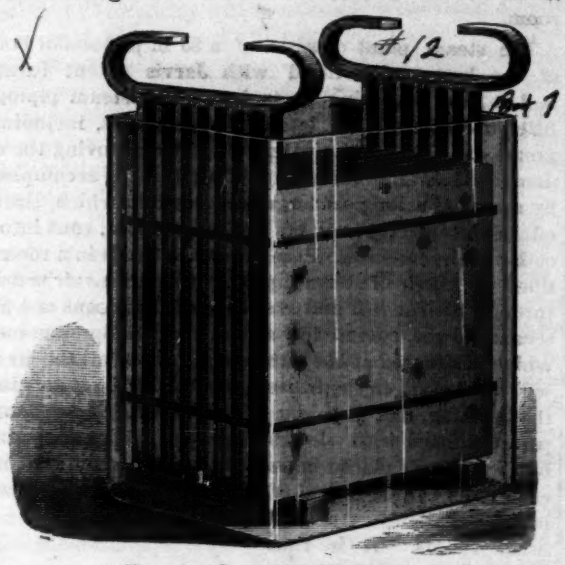


FIG. 1.—STORAGE BATTERY.

battery is brought into play. The broad theory of action in a storage battery is that if a current be sent into the cell the chemicals attached to the plates are decomposed, and when the charging current is removed these chemicals tend to return to their former composition, and until this action is completed a current is given out by the battery in the reverse direction from that in which it was charged.

The principles upon which the storage battery depends for its action were recognized early in the century, but it was not until the year 1859 that any success was obtained. It was then that Planté made a large number of experiments and found that lead plate and the lead salts offered the best medium for storing electricity in this way. He formed a battery by oxidizing the lead plate itself. This, however, required a long time to perform, and the battery, although a scientific fact, never came into practical use.

It was not until the year 1882, when the Faure battery was brought out, that the possibilities of the idea were fully recognized. In the Faure battery, instead of oxidizing the lead plate the lead oxide is artificially applied to the plate and hence the process of "forming" the plate by the old

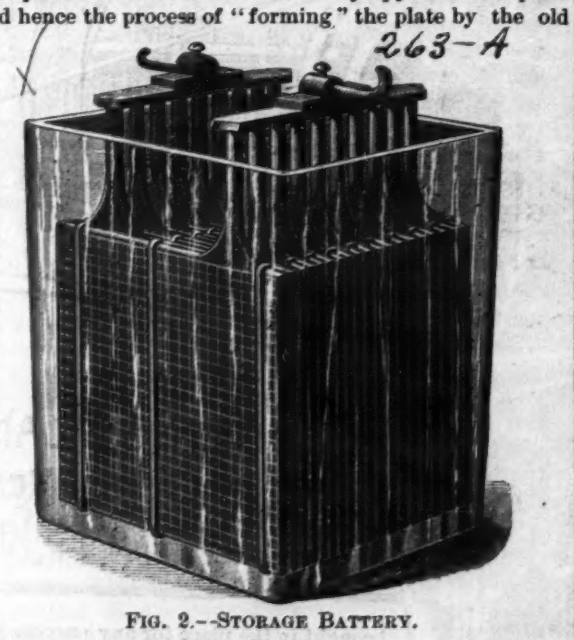


FIG. 2.—STORAGE BATTERY.

method was obviated and much time saved. Besides, this method gave the plates a far greater storing capacity, so that the same weight of cell could store up a larger quantity of electricity. Since 1882 the storage battery has been continually improved until to-day it stands as one of the important factors in the field of applied electricity.

There are in this country to-day several firms engaged in the manufacture of these batteries, and their styles each have merits peculiar to themselves. Our illustration, Fig. 1, represents the battery made by the Electrical Accumulator Company of New York. This is their standard type of cell, which is made up of fifteen plates, eight negatives and seven positives. It occupies the floor space of 8½ × 11 inches, is 16½ inches high and weighs 125 pounds. These batteries are in use in quite a number of buildings, where they are applied so that the engine need not be run at night, the electricity being drawn from the batteries which are charged in the day time by the dynamo. They have also found use in the lighting of railway trains, one of the Pullman vestibule trains being lighted by them. As a motive power for street cars they have also been applied and with good success.

Another firm manufacturing these batteries is the Julien Electric Company, of this city, which manufactures the battery invented by M. Edmond Julien, a Belgian engineer. While in general principle similar to other forms of storage battery, the Julien cell differs from them in the fact that the plate upon which the oxide of lead is applied is unoxidizable, and is not affected by the current.

The Julien Company have equipped a number of cars on the Boston & Albany Railroad with their batteries, and from the reports of the electrician of that road it seems probable that all the passenger cars will soon be lighted in that way. Street cars equipped with the Julien battery have also been running in New York and St. Louis.

We have mentioned above that the storage battery fills a void heretofore existing in the electric lighting plant from the fact that it serves as a reservoir which can be drawn upon when the dynamo machine is not in operation. It will be readily seen that this gives the storage battery a wide scope of usefulness. In the first place it not only adds considerably to the value of what may be called stationary plants, but it offers a means of distributing current from house to house in a simple way. It is evident that each house being supplied with one of these batteries, the current from the central station may be led into the house to charge the batteries and pass out to the next house. Thus a small current continuously applied, or only for a small part of the day, would store up sufficient electricity to do the entire lighting required at night.

Besides its use for lighting purposes the storage battery is destined to occupy a very prominent position in its capacity as a source of motive power for the propulsion of street cars and vehicles in general. Experiments which have already been made, and roads in actual operation for some time, prove abundantly that it is not only feasible to run street cars with storage battery, but that it will be one of the prominent methods of the future. Both of the companies mentioned above have already undertaken work of this character, and with good success thus far.

What makes storage batteries particularly valuable is the fact that they can be charged by almost any kind of motive power, whether it be regular or irregular. Thus they may be charged slowly at a low rate by small dynamos, and discharged rapidly at a high rate, or *vice versa*. They may be charged by steam engines, water-power or even windmills, constantly or intermittently, and will yield at an absolutely steady rate the energy stored, and, of course, wherever surplus power is available at odd times during the day or night it may be stored and utilized at pleasure.

One of the great advantages of accumulators in connection with electric lighting is the fact that they make it impossible for the light to give out at any time, as might otherwise happen upon a breakdown of the machinery; and again, the storage battery reduces the cost of operation in large and small installations on account of the fact that the engine can be shut down when only comparatively few lights are used. One of the advantages which the storage batteries in connection with the street car possess is that they not only supply light and power for the car, but, in addition, they make each car absolutely independent of the others so that the breakdown of one car leaves all the others unaffected.

This brief outline of what the electrical accumulator is now performing will give a good idea of what its future in this country will be. In the short space of time since the battery was introduced in America, it has been actively exploited and large factories are already engaged in its manufacture.

Austin, Tex.—The Austin Electric Light Company, with a plant of 110 Brush lights of 2,000 c. p., has consolidated with the City Water Company, and, as stated in this column last week, the new organization will be known as the Austin Water, Light and Power Company. Contracts have been made with the Westinghouse Company for the supply of three 1,300 light machines and four 80 h. p. boilers. The additional plant will be installed immediately.

The Belt Road, New York.—Hard luck pursues the Belt Line Horsecar Company. Since its stables at Fifty-fourth street and Tenth avenue were burned, and all its horses and stock were destroyed, it has been endeavoring to recover its business and former prosperity under the most discouraging circumstances. At present it has sufficient "bobtail" cars to accommodate the most of its traffic on the First avenue and Fifty-ninth street branch road, but the route to be covered, which extends all around the city from the Battery to Central Park and along the East and North River fronts, is furnished with only fourteen old-time dingy and "stuffy" cars. To keep these conveyances on any sort of schedule time, it has become necessary to retain five different relays of horses to work on both halves of the full route or circuit. The fire necessitated the purchase of 700 new or "green" horses. The torrid weather that has prevailed lately has had fearful effect upon those inexperienced animals. After dragging the heavily loaded cars in the broiling sun all day the horses have become so jaded and worn out at night that they have been dropping dead in their stalls at the rate of from two to five at a time. Out of the seven hundred head purchased by the car company but about four hundred remain. The stockholders and directors of the company are now considering the advisability of adopting some other mode of locomotion than animal power. The charter of the company permits this alteration. Some electric motor will probably be adopted. It is thought that by the use of some other than horse power less blockading would be caused, traffic would be made more expeditious and secure, and the road would be operated at a far less expense.—*New York World.*

The C. & C. Electric Motor.

BY S. S. WHEELER.

Now that electric motors are coming into such general use in Kansas City, some account of their construction will be interesting. The motors manufactured by the C. & C. Electric Motor Company were designed to meet the demand for a small and simply constructed machine in which the correct principles of dynamo construction were not all violated. It was sought to make those elements which are known to be the essential features of a thoroughly good machine,—high circumferential speed of armature, low internal resistance and strong magnetic field, etc., the first consideration, and *then* to design shapes and invent methods of manufacture which would enable the electrical requirements to be carried out more cheaply. The result of careful consideration of these things has led to the construction of a motor of the proportions shown in the engraving. Fig. 1, weighing about 12 lbs. for the ¼ h. p. size, and which is made on the American plan, of automatic machine work and interchangeable parts to a degree comparable with the manufacture of watches and other well established American manufacturing industries.

Each pole piece is equal in cross-section to the core inside the field coil, and both are made of one piece of the softest domestic iron (Burden's best), with the fibre running lengthwise, or in the direction of the lines of force. These cores and pole pieces are made from round bar iron of the size of the core, which are struck or drop-forged between dies having exactly the shape of the finished magnet, even including the small lugs on the outside to complete the horizontal support for the field coil washers, and insure a true winding of the wire. By the process of drop-forging, the inner surface of the pole piece is bent around a rounded part of the die, which exactly represents

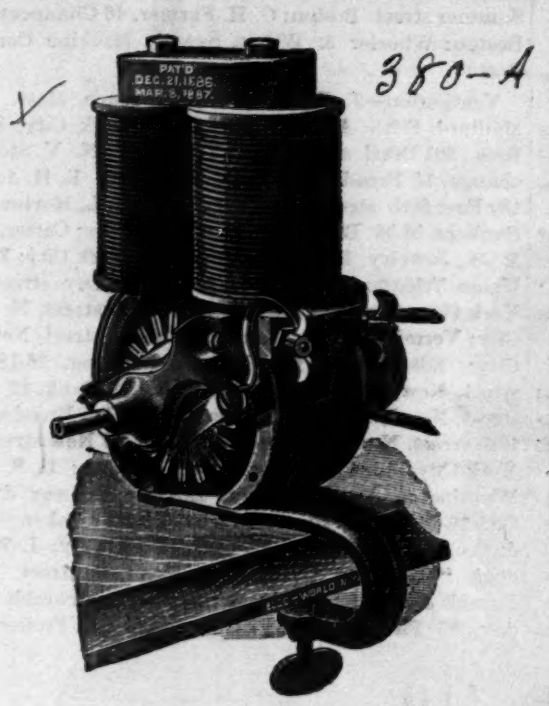


FIG. 1.—C. & C. MOTOR.

the space required for the armature, thus insuring a true and smooth circular space for the armature. The outside of the forging is likewise left, by the die, smooth and finished, and the irregularities or "fins" are all brought to the sides of the pole piece, where they may be trimmed off by the same trimming operation which is necessary to make a seat for the bearing plates.

Since the circular space for the armature is the important thing to preserve, all of the further operations of cutting and fitting the forgings and of assembling the motor are carried on with reference to this circle. The forgings are milled off bright at the upper end to receive the yoke, the forging being clamped in a vise which consists in part of a round iron block, which fits into the concave side of the pole piece and represents the armature space, and which is set at a fixed distance from the milling tool. The result of this operation is that when any two trimmed forgings are screwed to a straight yoke in the usual way the concave portions of the pair will agree in forming the required circle for the armature space. The forging is then clamped in another vise, consisting in part of a similar round block, and the two edges of the pole piece are trimmed off parallel, so as to bring all of the pole pieces to the same width, a straddle cut being taken by two milling cutters mounted on the same arbor. The forging, which is thereby finished to gauge in all respects, is next clamped against another round block inside of a box drilling jig, and all of the screw holes are drilled at one operation while the forging is held against the round block; so that when the bearing plates and other parts are screwed on, they will be true to the armature space.

The field coils are then wound between washers driven on the forgings, and the field is completed by screwing to the top a yoke having a cross section equal to the cores, which gives uniform magnetic conductivity throughout the frame. Cast or stamped brass bearing plates are then screwed to either side of the pole pieces, and in these bearings revolves the spindle or shaft, carrying a Gramme ring armature, of which the smallest size is shown in Fig. 3. This armature is of the following construction:

The iron of the armature core consists of semi-circles punched from thin sheet iron, on one side of which tissue paper has been pasted before punching. These semi-circles are laid together with the ends of alternate rings projecting at either edge of the built-up half cylinders so that the edges of the two half cylinders so formed will mate together or interlock. The half cylinders are then mated together at one edge, and a rivet is passed through, uniting them like the parts of a hinge. Upon the split ring so formed is slipped a flat helix of wire of a length sufficient to form the entire winding of the armature and consisting of only one layer, so that the operation

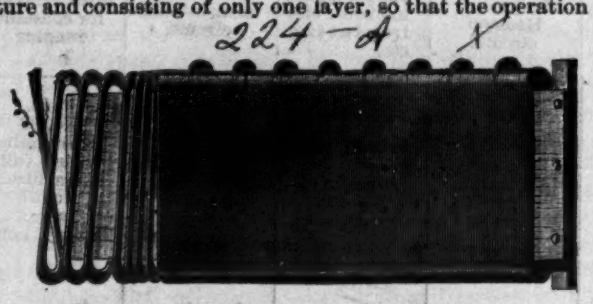


FIG. 2.—WINDING OF ARMATURE COILS.

of slipping it on is very simple; if there happens to be any defect in the insulation it can only short circuit or render useless a single convolution instead of an entire section. In order to get the required E. M. F., the wire used is flat, as shown in Fig. 2, and wound on edge, by which means it is possible to obtain the necessary number of convolutions with the necessary conductivity with only a single layer.

By this plan all complication due to unsymmetrical winding and unequal position of different convolutions in the magnetic field are avoided, as well as the various and complicated inductive effects of one section against its neighbors when built up close to each other in a good many layers in the usual way. As the winding is a simple or progressive helix, none of the convolutions overlap each other, and consequently there can be no serious short circuiting; and the bad inductive effects of the current in one section running in the opposite direction to the current in the other sections as the coils pass the point of commutation are reduced to a minimum. In addition, this winding has the advantage of producing a mechanically balanced armature, as it is obviously impossible to get the wire wound on deeper or in larger quantity on one side of the armature than on the other. The flat or beam shape of the wire also serves to stiffen the winding, and prevent its flying out of centrifugal force, thus rendering a circumferential outside lashing unnecessary. As the number of convolutions of wire on the armature is of great importance to the efficiency as well as the power of the motor, great attention has been paid to this point, and a ribbon is now used for one of the windings (type *E*), which is eleven times as wide as it is thick, and in some of the types of motor is made trapezoidal in cross section with the narrow edge out, the inclination of the sides of the wire being sufficient to allow the sides of consecutive convolutions to lie flat against each other on the inside of the ring. By doing this the amount of copper and consequent conductivity is slightly increased and the insulation is better protected, since it does not bear against the insulation of the next wire in a single line, as with a round wire, but in a flat surface. In fact, after a winding is in place, the

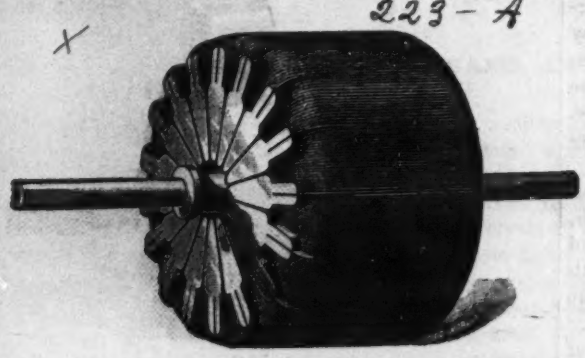


FIG. 3.—ARMATURE OF C. & C. MOTOR.

entire accessible insulation can be scraped off both inside and outside of the wound ring without injury.

This winding, which is shown in part in Fig. 3, is wound by an entirely automatic machine upon a flat mandrel equal in length to the circumference of the armature, so that when the mandrel is wound full with one continuous piece of wire there are just enough turns to fill one armature. The armature is divided into seventeen sections by seventeen equally distinct convolutions, which project about a quarter of an inch farther out than the others, and furnish means of making excellent soldered connections with the commutator. In forming the winding the end of the wire from the reel is fastened to a suitable catch at one end of the mandrel, which is then started revolving, the wire being held upright or on edge against the mandrel by a suitable guide arm, which is arranged to rise and fall so as to follow the surface of the mandrel as it revolves. A large ratchet wheel, divided into a number of teeth equal to the number of convolutions which the armature can carry, is impelled one tooth at a time at each revolution of the mandrel, and the completion of the revolution of this index wheel automatically stops the winding machine at the moment when the exact number of convolutions are wound, and calls the attention of the operator to the fact that the winding is completed. The projecting convolutions or loops of the continuous winding which mark the termination of each section are formed in the following way: a ratchet wheel and cam driven by the revolving mandrel control the movement of a rounded finger of steel, which slides along the edge of the mandrel, and is automatically brought directly under the oncoming wire at the instant when a particular convolution is about to be wound. The result is that this convolution is wound over the steel finger and made correspondingly higher than the rest. The finger is removed instantly by the cam at the moment before the next convolution begins to be formed. The whole operation of winding a complete and symmetrical armature of three hundred and forty turns of wire eleven thousandths of an inch thick and one hundred and ten thousandths of an inch wide, and transferring it from the mandrel to a wooden spit, occupies eight and one-quarter minutes.

The commutator, which consists of sector-shaped pieces of copper with projecting tails to embrace the loops above referred to, is secured by taper rivets to a fibre washer, and the latter is attached to a wooden block, through the centre of which the spindle is driven. This block is forced into the centre of the wound armature ring, so as to bring the commutator even with the end of the armature and cause the high convolutions or loops of the winding to project between the tails of their respective commutator strips. These tails are then pinched together and soldered to the high loops, the insulation having previously been scraped off the wire at these points.

The best proportion for the different dimensions of the

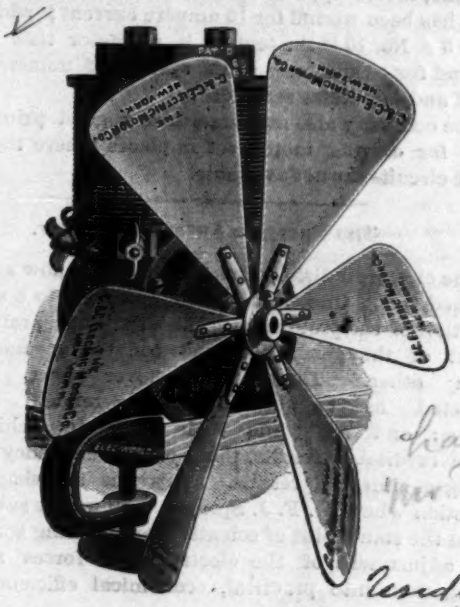


FIG. 4.—C. & C. MOTOR WITH FAN.

field magnets of this motor were determined by building a magnet of appoximately correct design, and then gradually increasing the diameter of the iron and decreasing the amount of copper wound on it, and decreasing the length of the iron and trying experimentally the effect of enlarging the mass slightly at different points. The results of each charge were noted carefully, and but a single change was made at one time, so that its effects should not be confused. By this process the present model was arrived at, and upon comparing it with some of the latest and most efficient dynamos, embodying the latest and best ideas, especially Dr. Hopkinson's latest machine, it has been found that this little machine is proportioned almost exactly like the large Hopkinson dynamo. The field in both cases is produced by from 500 to 600 ampère-feet of of winding for each square inch of field magnet cross section. The comparison is interesting, because this is probably the smallest extensively manufactured motor that has been made in strict accordance, as was the intention, with the recent ideas of correct dynamo construction, while the machines with which it is compared are some of the largest types. The electrical efficiency of the machine is about 70 per cent., and the net commercial efficiency has been pronounced by prominent electric light people who are using it to be about 55 per cent.

The machine described has a capacity of 2,000 ampère-turns each on the field and armature; that is, the magnets reach the best point of saturation with that current. As a great many of the motors are used on constant current circuits, and the various commercial circuits differ in current strength, it was necessary to make a separate class or type of winding for each current by varying the number of turns so as to get 2,000 ampère-turns on either circuit. The size of wire used was also varied inversely so as to produce the same sized coil and thereby maintain the same efficiency of copper in each type.

The windings for different circuits have been designated

by letters, while the different sizes of motors are known by numbers.

The following schedule shows the arrangement of sizes and windings:

SCHEDULE OF TYPES OF C. & C. MOTORS.

Size.	Power in h. p.	Height in inch's	Weight, lbs.	Winding. A: 20 amp., for battery, or U. S. circuit.	E: 10 amp., or Brush, etc., circuit.	F: 6⅓ amp., Thomson-Houston circuit.	G: Field in mult. arc for signaling bells, electroplating, etc.	L: 100 volts incandescent circuit.	N: 100 volts incan. circuit for constant running.
No. 1	⅛	7¼	13	Field, No. 10 wire. Armature flat wire.	Field, No. 12 wire. Armature, flat wire.	Field, No. 14. Armature, flat wire.	Field, No 21 in mult. arc. Armature, No. 20.	Field, No. 23. Armature, No. 27 wire. Takes ¼ amp.	Field, No. 23 extra pull, wound full. Armature, No. 27 wire. Takes ¼ amp.
No. 3	¼	10½	50	Field, No. 6 Armature, No. 13.	Field, No. 9. Armature, No. 16 wire.	Field, No. 11. Armature, No. 19 wire.		Field, No. 13. Armature, No. 20.	
No. 5	1	12½	77	Field, No. 5. Armature, No. 12.	Field, No. 8. Armature, No. 16 wire.	Field, No. 10. Armature, No. 18 wire.			
No. 8	2	15½	127		Field, No. 8. Armature, No. 15.				

Thus, motor type 1 E No. 500 is the 500 ½ h. p. motor that has been wound for 10 ampère current; while motor type 5 A No. 10 is the tenth 1 h. p. motor that has been wound for 20 ampères. This system of nomenclature is brief and facilitates reference.

The company also manufactures a good primary battery for driving motors set in places where the electric light circuits are not available.

The Sprague Automatic Motor.

The electrical distribution of power is now an accomplished fact. One of the main obstacles to a successful solution of the problem was the want of accurate adjustment of the generating and converting machines to each other. These had never been so constructed as to be definitely related to each other; and so, while their separate achievements gave creditable results, their united efficiency failed to bring commercial results. This was the shape of the question when Mr. F. J. Sprague took up the subject, and from the standpoint of scientific engineering sought such an adjustment of the electromotive forces as should bring them into practical, economical efficiency and co-operation.

In one immense field of industry, the Sprague motors operate to-day so effectively that the question of further improvement is hardly debatable, and it can be truthfully said they fully answer all the requirements made of them, and, for efficiency and adaptability to work, are unexcelled by any other electric motor yet invented.

This field—the transmission of power for industrial purposes, in mechanical application—is satisfactorily filled by the Sprague motor. Here it is hourly proving itself safe, prompt, reliable, compact, efficient and economical. The motors are free from sparking, and require little care. They are built with but one movable part, need few repairs, and have all the parts interchangeable.

These machines are now being built of capacities ranging from one-half horse-power to fifty horse-power each, and as they are guaranteed as to capacity, efficiency and thorough mechanical construction by a corporation with ample financial ability, they present to power users the most desirable motive power in the market.

The Sprague motors are now being used on all classes of the electric circuit, having been formally adopted for use on the Edison circuits; and they are being used on the Westinghouse, Brush-Swan, Thomson-Houston and United States circuits in New York, Chicago, Boston, Des Moines, Elgin, Oskaloosa, Pittsburgh, Chester, Williamsport, Lancaster, Shamokin, York, Detroit, Topeka, Cincinnati, Springfield, New Brunswick, Fall River, New Bedford, Milford, Taunton, Lawrence, Woonsocket, Fort Meyer, Waterbury, Annapolis, St. Louis, Abilene, Pawtucket, Syracuse, Canada, the Argentine Republic, Berlin and Milan.

In considering the transmission of power over a long distance, or from a central station in a manufacturing district, the question of the efficiency of the motor becomes one of great importance. Motors vary in their efficiency. To truly answer commercial conditions, the current used should be almost directly proportional to the work done.

The higher the efficiency of the motor, the more nearly will the law hold. It has been the aim of the Sprague Company to build its motors of high efficiency, and they are seeking to increase this in every possible way. Small machines are not as efficient as large ones, nor is any motor of equal efficiency under all loads; but that of the 10 h. p. Sprague motors has now reached 91 per cent., and the Sprague Company are seeking even a higher atttainment.

The application of the Sprague motor to general uses has been very wide. The motors are now operating elevators—both passenger and freight—ventilators, sewing machines, printing presses, lathes, circular saws, etc., etc.

We give names of some of the users of the motors, of which five hundred are now in use, all over the country:

Buffing Lathes—Bigelow & Kennard, Boston, Mass.; W. H. Blake, 119 Elliott street, Boston, Mass.; Needham & Littlefield, New Bedford, Mass.

Coffee Mills—Driscoll, Church & Hall, New Bedford, Mass.; George Sears, Elgin, Ill.; N. F. Swan, Elgin, Ill.; Union Tea and Coffee Company, York, Pa.; Edison Electrical Illuminating Company, Lancaster, Pa.; Vinal & Tuell, New Bedford, Mass.

Circular Saws—James Conant, 3 Franklin street, Boston; T. W. Norman, 116 Eliot street, Boston; Rhodes, Third street, Williamsport, Pa.; John Notter, New Bedford, Mass.; Prang Educational Company, 7 Park street, Boston.

Elevators—Pemberton Mills, Lawrence, Mass.; J. L. Morgan & Co., 47 Fulton street, New York City; Packard & James, Maiden Lane, New York City; Thomas Dill (freight) elevator, 17 to 25 Eliot street, Boston; Thomas Dill (passenger) elevator, 17 to 25 Eliot street, Boston; J. L. Wells, Des Moines, Ia.; John D. Bates, 25 Kingston street, Boston, Mass.; Elgin *News*, Elgin, Ill.; Union Institution for Savings, 590 Washington street, Boston, Mass.; Springfield Electric Light Company, Springfield, Mass.; D. L. Sheplie & Co., 39 Avon street, Boston, Mass.; James S. Stone, Purchase and Pearl streets, Boston, Mass.; John Goldthwaite, 47 Purchase street, Boston, Mass.; James S. Stone, Boston, Mass.; Peck & Hall, South and Tufts streets, Boston, Mass.; Edison Electric Illuminating Company, Williamsport, Pa.; Huber & Kalbach, Oskaloosa, Ia.; Simonds Manufacturing Company, 50 Cliff street, New York City; Wm. H. Zinn (passenger), 501 Washington street, Boston, Mass.; Edison Electric Illuminating Company, Rochester, N. Y.; Stein Manufacturing Company, Rochester, N. Y.; Nathaniel Emmons (passenger), Temple Place, Boston, Mass.; Manufacturers' National Bank, Boston, Mass.; Jas. T. Eldridge (passenger), 241 Tremont street, Boston, Mass.; Knickerbocker Building (passenger), Tremont street, Boston, Mass.; Allen Brothers, 355 Federal street, Boston, Mass.; J. K. Willis, 115 Federal street, Boston, Mass.; George A. Plummer (passenger), 531 Washington street, Boston, Mass.; Mrs. Crocker, milliner (passenger) Washington street, Boston, Mass.; L. P. Hollander (2 passenger, 2 freight), Potter Building, Boylston street, Boston, Mass.

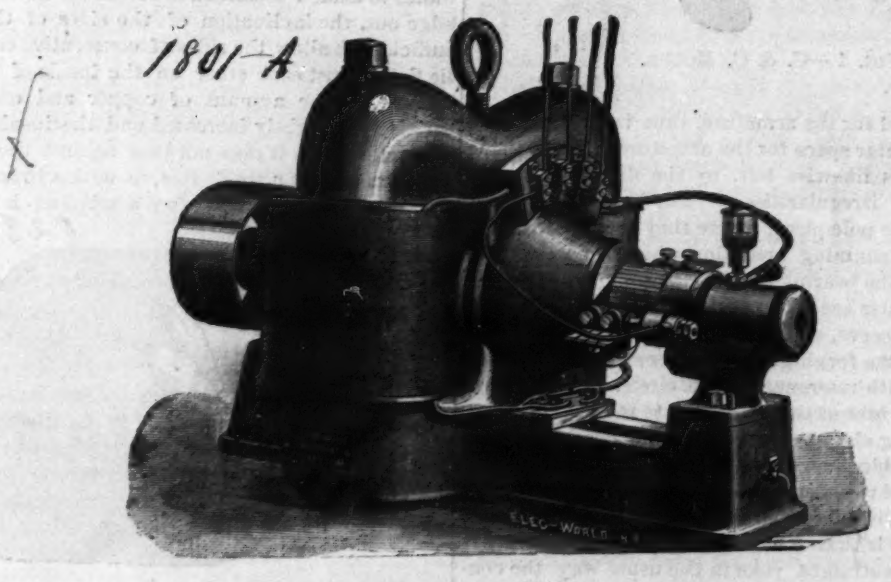
Lathe Work—Needham & Littlefield, New Bedford, Mass; Fire Department, City of Chicago; H. M. Kinsley, Chicago, Ill.; Edison Electric Illuminating Company, New Bedford, Mass.; Needham & Littlefield, New Bedford, Mass.; Wheeler & Wilson Sewing Machine Company, Boston, Mass.; Bay State Cash Railway Company, 34 Bloomfield street, Boston, Mass.; Fitz Manufacturing Company, Des Moines, Ia.; Downes, Bosworth street, Boston.

Printing Presses—C. A. Heyer & Sons, 576 Washington street, Boston; Elgin *News*, Elgin, Ill.; Cheshire Bros., Des Moines, Ia.; Electric Light Company, Pawtucket, R. I.; *American Inventor*, Cincinnati, O.; Allegheny County Light Company, Pittsburgh, Pa.; Wm. M. Butler, Exchange street, Rochester, N. Y.; H. A. Wadsworth, 307 Essex street, Lawrence, Mass.; *Home News*, New Brunswick, N. J.; J. U. Gignere, Woonsocket, R. I.; John P. Smith (11 cylinder presses), Rochester, N. Y.

Polishing Machines—Gorham Manufacturing Company, 9 Maiden Lane, New York City; L. Newman, 75 Nassau street, New York City; First Cincinnati Edison Company, Cincinnati, O.; T. A. Edison (laboratory), Florida.

Sewing Machines—J. R. Farrell, 14 Boylston street, Boston; H. C. Blue, 48 Summer street, Boston; H. Lord, 89 Summer street, Boston; C. H. Farmer, 46 Chauncey street, Boston; Wheeler & Wilson Sewing Machine Company, Boston.

Ventilation—J. Butterworth, Lawrence, Mass.; Henry Maillard, Fifth Avenue Hotel, New York City; Leggett Bros., 301 Pearl street, New York City; N. Y. Stock Exchange, 14 Broad street, New York City; E. H. Johnson, 139 East 36th street, New York City; H. L. Horton & Co., Bankers, 54-56 Broadway, New York City; Carter, Sloane & Co., Jewelry, 15 Maiden Lane, New York City; Western Union Telegraph Co., Broadway and Dey street, New York City; Simonds Mfg. Co., 50 Cliff street, New York City; Vermilye & Co., bankers, Nassau street, New York City; Edison Co. for Isolated Lighting, 16-18 Broad street, New York City; Third National Bank, 22 Nassau street, New York City; Aitken, Son & Co., Broadway and 18th street, New York City; F. Erblin, 17 New street, New York City; Lord & Taylor, New York City; U. S. Senate, Washington, D. C.; Sprague Electric Railway & Motor Co., 16-18 Broad street, New York City; Baker, Seymour & Co., 3 Exchange Court, New York City; J. Wackendorf, "Old Elm" Restaurant, Tremont street, Boston; Francis & Co., 8 Summer street, Boston; Schmidt & Friday, 95 Fifth avenue, Pittsburgh, Pa.; P. Freiler, Elgin.



SPRAGUE AUTOMATIC ELECTRIC MOTOR.

Among the special problems of the transmission of power, which can be now accomplished by the Sprague motors, may be mentioned ventilation of mines, operation of drills and compressors in mines, transmission of power from long distances to operate the mills at the mouths of mines instead of transferring the ore long distances to the mills. All through the western territory there are a very large number of mines, many of which are operated to-day under very great expense, an expense so great that only the highest grades of ore can be used, while hundreds and thousands of tons of the lower grades are thrown away because they cannot be profitably worked. These lower grades of ores with the present method of working cannot be transported to distant mills, and must

therefore wait until civilization has brought railroads sufficiently near to make their work profitable, or else they must be worked up by mills at the mines and the power transported to these by electricity. Because of the lack in the past of a suitable system for such transmission, many mines have been abandoned, while now a great many of them could be profitably worked up by water-power, which is only a few miles away. In other places large water-powers are available in comparatively short distances from places which are advantageously situated for manufacturing purposes in all other relations. The present proposed method of transmitting power in such cases has been to build flumes or canals, and conduct this power by water. All this may be much more advantageously done by the use of the Sprague motors, even when dealing with large units of power.

In agricultural work a large field opens up. In jute production a large proportion of the cost consists in the transporting of material from the fields to the machines, much of the material being waste product, and its transportation, of course, being so much waste labor. Such waste should be burnt in its place. Such industries can have a central station, run a couple of wires out to different parts of their field, and couple on at any point with any of their threshing or other machines.

Railroad work both for mines and streets, elevated and substructures, can be advantageously operated by the Sprague motors, and they are now being built by the Sprague Company for such uses.

The progress and rapid growth of the company's work has necessitated making some changes in their arrangements for manufacturing, and the work is to be divided into two classes, one standard and the other special. They are reducing all the larger sizes of standard constant speed machines from, say, 8 to 50 horse-power, to uniform standards as regards to external appearances and general dimensions, these machines being built for different electromotive forces. The first few of such machines will be built under the immediate supervision, and at the works of this company, which are now running until late at night on account of the press of work. A contract has been entered into between the company and the Edison Machine Works, by the terms of which, at the new factory of the Edison Machine Works in Schenectady (which is to be the best equipped large factory in the United States for the manufacture of dynamo-electric machinery), nearly all the standard machines of this company will be built, and a very large number of machines, probably 150 to 200, will be carried in stock at all times, the deficiencies caused by shipments being promptly made up, so that in the near future they will be able always to ship almost any type or class of standard machine on short notice.

The other part of the manufacturing, which involves the special application of motors to the various arts and to a very large number of mechanical appliances which are to-day operated by steam, will be done at the experimental factory in New York City, which is equipped with the best special tools, and under the immediate supervision of the electrician of the company.

For various uses there are now in process of construction at the two factories we have alluded to, about one thousand Sprague motors, aggregating over four thousand horse-power.

The Thomson-Houston Electric Light System.

Prominent among the great electric lighting systems of the world is that of the Thomson Houston Electric Company—a system very favorably known to all the inhabitants of Kansas City through the excellent service rendered by the local company using it. The Thomson-Houston system is now being operated by no fewer than 200 local electric light and gas companies in this country, and has been widely adopted abroad.

Professors Thomson and Houston, occupying chairs of science at the Central High School of Philadelphia, had already spent much time in the joint study of electric lighting, when, in 1878, their work culminated in their production of a dynamo-electric machine, which, under practical test developed points of special excellence. Its performance, in connection with other electric lighting apparatus, attracted the attention of a number of capitalists, who organized a company and commenced to manufacture electric-lighting appliances, Professor Thomson being their electrician. The managers, New England business men of sterling enterprise and restless activity, lost no opportunity to advance its interests, liberal sums were expended on the perfection of its apparatus and the purchase of such patent rights as were necessary, the earnings and profits of the corporation being turned into its treasury so that its efficiency might be increased, until to-day it stands as one of the most prosperous, successful and independent concerns devoting its exclusive attention to electric lighting. The headquarters of the company, at 178 Devonshire street, Boston, are a scene of busy activity, a large staff of clerks being employed in the transaction of office business there, as well as at the company's western office in Chicago. The Thomson-Houston International Electric Company has been specially organized to relieve the parent company of all except the vast and rapidly-growing home business, and in attending to the foreign relations of the company it finds quite enough for its ample establishment to care for. The practical work of the company is, however, accomplished at immense works, in the town of Lynn, Mass., where a force of nearly 1,000 hands is employed. It is undoubtedly one of the most complete establishments of its kind in the country, probably in the world. Everything connected with the company's system of electric lighting is manufactured at these extensive works, the raw material only, in the shape of rough castings, sheet metal, wire, lumber, etc., being purchased outside. The most careful attention is paid to the selection of the material for the various parts, everything purchased being subject to the manufacturers' guarantee and the company's crucial examination and test, it being their object to avoid *ab initio* the possibility of defects.

The company commences by making all the drawings and plans and all the patterns for its work in its own shops, the draughting room containing about ten expert draughtsmen, and the pattern shop, equipped with the finest machinery, giving employment to an equal number of skilled artisans. The patterns made are sent direct to a foundry employing about fifty men and running almost entirely on the company's work. The cleaned castings received, after careful inspection, go to the machine shop, where they are planed, drilled and fitted. The "field," as the stationary arrangement of coils in a dynamo is called, is of peculiar shape in the Thomson-Houston machine, consisting of two heavy castings, bored out so as to leave between them the spherical armature, a portion of the work that is accomplished by tools of special and exceedingly ingenious character, designed by the company for this work. In the same department in which these field castings are being bored and fitted, the framework of the dynamo—also heavy castings—the shaft of the revolving armature and its core, consisting of cast-iron heads connected by cast-iron bridges so as to form a strong but comparatively light hollow sphere, are also made and put on. Extraordinary care is exercised to insure the proper adjustment of the different parts of the machine, which are fitted together while undergoing the various finishing processes, so that they must necessarily be absolutely true when finally assembled. As soon as the parts have been put together and found perfectly true, the machine is taken apart and the fields and armature are sent to be wound. The core is covered, first with iron wire, then insulated with proper materials, such as paper, shellac, India-rubber cloth, etc., and over all this insulated copper wire is again wound in a systematic manner and with the utmost care, more shellac being used to insure perfect insulation. Bands are now put on to prevent any separation of the wire layers under the influence of the powerful centrifugal action caused by the rapid rotation of the armature, and the massive contrivance is then baked in a steam oven to expel any moisture, alcohol vapor, etc., that might remain in it and impair its insulation. Meanwhile the two parts composing the field have been treated in the same manner, the different sections are again assembled, fitted together, treated to a coat of paint, and the completed machine, with the various regulating devices and other fittings, to which we shall subsequently refer, goes to the dynamo testing room.

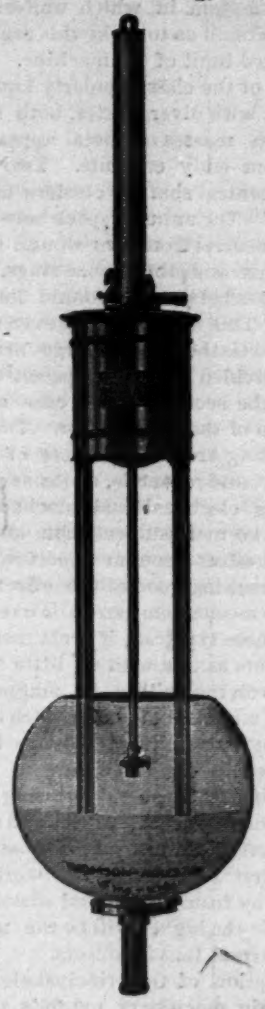
In a separate department the incandescent dynamo machines and those employed in furnishing the current for the alternating system of lighting are manufactured, being treated in detail in a similar manner.

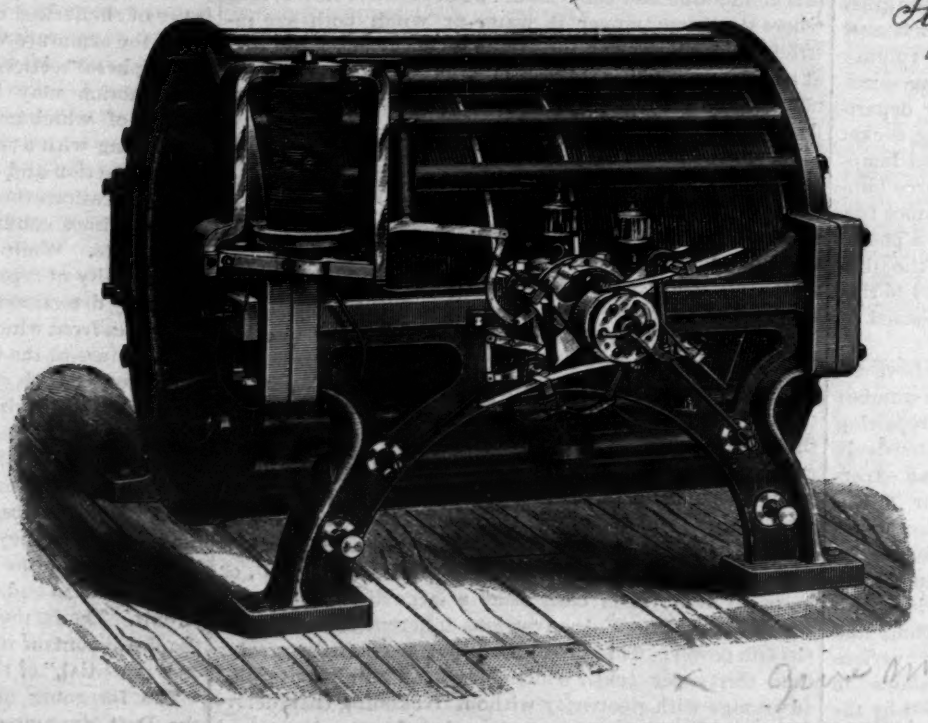
All through these departments the closest record of the progress of each part is kept, as well as of the performance of the finished machine in the test room and all the parts of each machine of the same type and capacity being interchangeable, it is an easy matter, not only to trace subsequent defects to their origin, but in case repairs are necessary, to furnish exactly fitting parts.

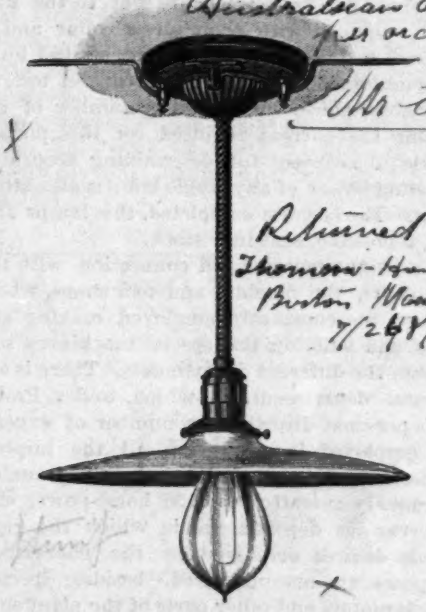
Upward of 400 complete lamps are turned out each week in the arc light department, in which some fifty engine lathes, twelve gang-spindle drills, nine screw machines and seven sensitive drills, together with milling machines, upright drills, planers, shapers, emery grinders, etc., in proportion are employed. All the parts of the lamps, including their frame-work, etc., are drilled in gangs, so that there can be no doubt as to their interchangeability; many special tools are also employed in their completion, and each part of every lamp is inspected in detail before going to the assembling-room, by men whose business it is to do nothing else. Here they are again inspected, the finished lamp undergoes careful examination and then goes to the test-room, where its record is completed by a thorough test of its practical operation before it finally reaches the shipping department.

The incandescent lamp department is unquestionably one of the most interesting, if not the most interesting, branches of the company's vast business.

In the first place, we may state that the lamp consists of three essential parts: the glass bulb, the filament of carbon and the means for carrying the electric current to this carbon filament from the wire, without destroying the vacuum in which the carbon glows. Of the glass bulbs there is little to be said: they are made of fine glass, carefully tempered, and when received from the glass-house resemple Florence flasks with exaggerated necks. The carbon filament and its connections constitute the keystone to the success of the incandescent light, and the filament itself has been the subject of much experiment.







FIGS. 1, 2, 3.—THOMSON-HOUSTON DYNAMO AND LAMPS.

Various carbonized materials are used in the different systems of lighting.

In the Thomson-Houston lamp, the filaments are treated in the most scientific manner to prepare them for their work. After careful test to establish their power of resistance, they are fixed in an apparatus that plunges them into a bath of hydro-carbon vapor, a vacuum being created in the receiver previous to the admission of the vapor. The passage through the filament of a current of sufficient intensity to render it incandescent, causes the decomposition of the vapor, and pure carbon is deposited on the filament and in its pores in such proportion as to render its power of resistance, as well as its substance, uniform, and it at the same time becomes tough and elastic, and permanently assumes the figure 8 shape, characteristic of the company's lamps. Meanwhile, ingenious little drop presses and drawing machines have been at work forming tubular sockets on the ends of two platina wires, which are incased in glass to insure their proper insulation, and into these sockets the free ends of the filament are inserted. A bath in a volatile carbon fluid, in connection with a peculiar cement and the passage through it of a current of electricity during immersion, inseparably attaches the carbon to the platina stems.

In the glass-blowing department, the hitherto round ends of the bulbs have been drawn into a nipple to receive a tube whereby to exhaust the air from their interior, and the mounted filament is then blown into the neck of the bulb, air tight. The bulb is then attached with one or two others of its size to a single tube and is sent to the pump-room in order that the air may be exhausted from its interior and the combustion of the carbon be rendered impossible, its resistance to the flow of electricity increased and its luminosity enhanced. To accomplish this purpose, the lamps are attached to tubes in which, with the aid of an air-pump, a vacuum equivalent to the barometrical mercury column (29 inches) has already been created. On the principle of an injector, a stream of mercury falls rapidly from a small jet vertically down the tube connected with the interior of the lamp, and by this means almost complete exhaustion of the air is secured. Then a current heats the filaments to incandescence, at once testing them, rarefying the residue of the air present and facilitating its complete exhaustion, together with the gases evolved from the heated carbon. The lamps, which now contain about the millionth part of their original volume of air are then detached, the entire process having occupied about five hours; they are sent to the fitting department, supplied with their screw collar and plug socket and sent to the test room. Here several hundred lamps are simultaneously undergoing careful test, a three hundred horse-power engine and a number of dynamos furnishing the current required for this purpose: a photometric department for determining accurately the illuminating power of any single lamp is also attached to this room. The last test completed, the lamps are cleaned up and, if possible, sent into stock.

We might mention, in connection with the above departments, the machine and tool shops, where a number of men are constantly employed making and repairing tools and building the special machinery so extensively used in the different departments. There is also an experimental department, in which, under Professor Thomson's personal directions, a number of expert mechanics are employed in producing all the improvements he devises; a fully-equipped woodworking establishment, its machinery operated by a 25 horse-power electric motor, and various departments in which the regulating and safety devices employed by the concern for various purposes are manufactured, besides special shops in which motors and other parts of the plant supplied by the company are produced. All through the works and in every detail system and order prevails, and each department has its responsible head, usually some man graduated from a technical college and practically trained in the company's shops. All together, an aggregate of nearly 1,000 hands and 450 horse-power is employed in the works, which are lighted by about 300 incandescent and 120 arc lights and heated by steam. The boilers are furnished with pure water from artesian wells on the premises. The buildings, substantially erected of brick and four stories high, furnish an area of about 80,000 feet; but these accommodations, although they have been doubled within a year, have already been outgrown, and land has recently been purchased for the erection of a factory that will in magnitude duplicate the present establishment.

Used directly in connection with an electric light plant are the electric motors, in many cases—indeed, in most cases—operated directly from the wires that furnish the electric lights. The motors of this company are very simple in design, strongly and compactly built, and are of the very highest degree of efficiency. They require but little floor space, exact but little attention, and are being very rapidly introduced for the purpose of running printing presses, elevators, fans, sewing machines, and every variety of manfacturing machinery. The electric motor is also very largely used for street railway purposes, and this field alone promises to be a very large and prosperous one in the near future. A large portion of the new factory about to be built by the Thomson-Houston Co. will be devoted to the manufacture of their system of electric motors, of which they are now building various sizes from ½ to 30 horse-power. During a few days, while a portion of its boilers were undergoing repairs, it operated a large part of its machinery by means of a motor which carried at times a load of 60 horse-power, a thing which is not known to have been accomplished by any such motor manufactured by any other company.

A Familiar Description of Some of the Daft Dynamo-Electric Machinery.

Electrical energy is so rapidly acquiring—if it may not be said to have already acquired—a recognized place in our industrial life as to render peculiarly seasonable at the present juncture a wide publication in untechnical language of its general nature, properties and claim to public confidence.

The form of electrical energy with which this description has to do manifests itself as a current, and may proceed from several sources, the most familiar of which is the galvanic battery. This, however, is for economic reasons outside the pale of commercial usefulness, and must continue to be until the discovery of some electro-positive element cheaper than zinc, which at present ranks highest for intrinsic energy in relation to cost.

Without resorting to demonstration, it may be accepted that the relative costs of zinc and coal as power producers are fairly expressed by their respective market prices.

Dynamo-electricity, as its name implies, is derived from force or power, and is the only form that, thus far, has justified its application for motive purposes.

The original force may be the natural source of power, wind or water, or the artificial one, a steam engine. This is a matter determined entirely by specific considerations.

An almost invariable question by those whose attention is for the first time called to the subject of dynamo-electric power is the following: What advantage lies in its use when, at the outset, resort must be had to some prime mover to initiate it, and why not apply the steam, wind or water directly to the work to be done, instead of first converting this power into electric current, conducting it a greater or less distance, and reconverting it into mechanical power with the expense and losses inseparable from this conduction and conversion? The answer is obvious where the prime mover is water or wind; both are restricted to certain localities. Dynamo-electricity generated at some convenient point transmits its equivalent of power cheaply and reliably wherever it is needed, and thus justifies its employment.

Where the prime mover is a steam engine, the suitability of electric power is not so immediately evident, but is quite as easily demonstrable. Mechanical power may often be wanted in a situation to which it is difficult, if not impossible, to convey fuel and water, or may be needed in subterranean work where the gases of combustion would render the presence of a steam engine impossible. Exceptions such as these are not disposed of by quoting truisms.

But without relying upon these exceptions to establish the rule, the fundamental advantage of electric power over the direct application of steam lies in its marvelous capacity for economical subdivison, and the recognized wastefulness of small steam engines, as compared with the larger improved types. If the latter will give a horse-power for two or less pounds of coal, while small stationary or locomotive engines require from four to eight, or more, pounds, it is clear that a large discount may be profitably paid for the conversions inherent to the use of electric power. This discount is not necessarily greater than thirty per cent., which leaves an ample margin of advantage with electricity without reckoning that derivable from the less first cost, reduced attendance and diminished depreciation pertaining to its mechanism.

But the most striking characteristic of electric power is the one first mentioned, viz., its capacity for economical subdivision. That may be accounted for by the instantaneousness with which a current pervading a complex circuit adjusts itself to the demand made upon it along the route. Water, or any other fluid, or even a gaseous medium such as steam, has the property in some degree; but the operation is so retarded by friction, in the first case, and the effects of the disappearance or liberation of heat in the second, as to be of no practical value whatever. With an electric current, the adjustment is immediate.

In the case of a double track railway equipped with steam locomotives, and with an equal traffic in both directions, each separate engine must be competent and ready at all times to perform the maximum work—in the shape of load, speed and gradient—that can ever be required of it; and the greater part of the time must be burning fuel uselessly, in spite of all efforts to avoid so doing, while not a moiety of its costly mechanical capability is called into action.

Were the same roads equipped with dynamo-electric motors, the current pervading the double line need never be more than equivalent to the average work of each motor multiplied by their number; and waste of it is therefore impossible.

A dynamo-electric power plant includes a prime mover of some sort, a dynamo generator, a circuit and motors. The generator and motor are substantially similar in design, and consist principally of a field magnet and armature. The latter is, in brief, a closed coil of wire which, being revolved by some extraneous power before the poles of a magnet, is pervaded by a current that enters the circuit and is conducted by it to the motors in connection therewith. These it causes to revolve in a direction opposite to that of the generating armature, and this motion is available for mechanical work. Experience has shown certain proportions between the component parts of the field magnets to be desirable—for example, the length of and diameter of cores, etc., and there is no radical departure from these canons in the Daft types. The winding, however, has certain characteristic features which contribute to the remarkable maintenance of efficiency under wide variation of load and the freedom from local or extreme heating of the machine.

The field-magnets of generators have both shunt and series coils; the former in order to magnetize the fields sufficiently for the required potential when running light, and the latter, through which the whole current circulates when the machine is under load, to increase their magnetic intensity *pro rata* with the counteracting influence of the excited armature. The responsiveness of this arrangement to the variations of load coming upon the generators is almost phenomenal. They run absolutely without attention—except as regards lubrication—day in and day out, preserving a constant potential throughout the circuit without adjustment or manipulation of any kind.

In railway motors the rate of efficiency is kept uniform by the arrangement and proportions of the various field coils, which, through the combinations within the scope of the regulating gear, preserve that nearly constant ratio between the developed resistance and the work done at any instant which is inseparable from such a condition.

The fields of stationary motors, in which uniformity of speed is essential, are so wound as to make this regulation automatic within the stated limit of the machine.

The Daft armature is of the class popularly known as the "Gramme ring," but with divergencies, both radical and important. No large masses of metal appear in it, which precludes loss from eddy currents. Two bronze rings are connected to a central shaft by clusters of radial spokes termed "spiders." The annular space between the rings is filled flush with neutral iron wire wound circumferentially, and over this and the bronze rings, with a layer of shellacked canvass between, is wound longitudinally the armature wire. This is laid on in an even number of peripheral sections and in the case of large armatures each section may be divided into four spaces, the wire in each of which or in the section, as the case may be, connecting with a section of the commutator. The details of construction and winding are the subjects of patents and applications therefor, and reconcile, as far as possible, the sometimes conflicting electrical and mechanical requirements. While it is no more subject than another to the necessity of repair, it offers peculiar opportunities for the ready detection and making good of the effect of contingencies from which no mechanism can claim exemption. No armature of the Gramme type can, it is claimed, carry continuously such currents as this with so little heating.

This armature wire revolving within its magnetic field is divided into halves by a neutral diameter, each of which is pervaded by a different current that extends to those sectors of the commutator on the same side of the zero line. Metal strips, called "brushes," pressing against these sectors as they revolve beneath, collect and transmit the current to the exterior circuit. Part goes to magnetize the field and the rest to perform the work of the circuit. The farther away from the neutral diameter that the brush contact is made the higher will be the intensity, or "potential," of the current that it collects.

The foregoing description of the principal elements of the Daft dynamo-electric machinery exhibits the compromise brought about, by practical use and routine service, between the requirements of abstract electrical formulæ and mechanical and commercial limitations. A few instances of its general applicability are herewith cited.

As for electrical railways: Of those equipped and run upon the Daft system which have been long enough in operation to furnish a record from which deduction of any value can be drawn, but two are cited, viz., the Baltimore & Hampden line of the Union Passenger Railroad Company, which is upon the point of completing the second year of uninterrupted use, and the Los Angeles Electric Railway in California, which has just concluded six months actual service without an hour's intermission.

The former covers a distance of over two miles, includes gradients varying from level to near 7 per cent. and curves of 40 feet radius, and maintains an average speed of eight miles an hour. Independent motors are used, and the conductor is a third rail laid between the other two. The company's superintendent, Mr. T. C. Robbins, instituted, for his own satisfaction, a series of observations covering a year of the electrical operation of the road and compared it with a similar record for a period when animal traction was employed. The comparison is appended. The only comment necessary is that it is published over the official signature of Mr. Robbins, and is the only official statement of the kind in existence:

In the year ending Sept. 1, 1885, with horses at a speed of 4.033 miles per hour:	
The passengers carried were	227 153
" gross earnings were	$11,357.75
" cost of motive power was	7,117.50
" " " per passenger mile was	.0156

In the year ending Sept. 1, 1886, with electricity, at a speed of 8 miles per hour:

The passengers carried were	311,141
" gross earnings were	$15,557 05
" cost of motive power was	4 380
" " " per passenger mile was	.007

In this peculiarly unfavorable case, electricity accomplishes, viz:

I. An increase in traffic of ..... 37 per cent. nearly,
II. A reduction in cost of motive power in gross of 38 " "
III. A reduction in cost of motive power per passenger mile of ..... 55 " "

The Los Angeles Railway is five miles in length, and is of the overhead conductor type. It is equipped with four independent motors and four motor cars, and maintains an average speed of twelve miles per hour. The traffic has developed enormously since the opening of the road, and public opinion of it is very accurately expressed by the subjoined quotation from Mr. H. C. Moore, prosecuting attorney of San Jose: "I have ridden over it, and must say it is the smoothest-riding road I ever rode on. You actually cannot tell, unless you watch some stationary object, just when you start and when you stop. It is a wonderful thing. Now, the Market street road in San Francisco is the finest cable road on earth. It cost hundreds of thousands of dollars a mile. Your electric road is built very cheaply on an ungraded street whose soil is like ashes when dry and like mortar when wet; and still, for comfort and smoothness, it is perfection. It is as much ahead of the Market street cable road as the Market street road is ahead of a horse railroad. I am more than satisfied with its workings."

The distribution of electric power throughout a community for all those minor purposes for which steam is now employed is its most novel application, and only those who have made the matter a study are aware of the foothold it has already obtained.

The same economy observable in electric railway propulsion is encountered in this phase of the subject, and it is no exaggeration to say that it is no more troublesome, dangerous or obtrusive than gas or water in a house.

Like them, power is conveniently "on tap." The exclusive use of currents of low potential renders impossible any fatal or even disconcerting accident.

A brief description of two or three installations for the distribution of electric power on the Daft system is appended. It will inform the reader what has already been accomplished in this direction.

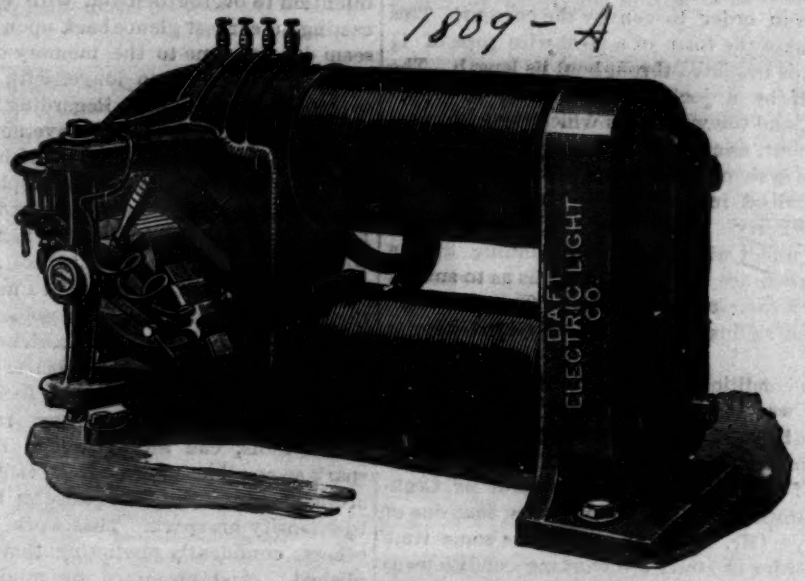


FIG. 1.—DAFT ELECTRIC MOTOR.

The Electric Power Company of New York City has been running three years, and has in that time become an indispensable necessity to the region which it serves. Its power station is at the head of Spruce street, and its lines stretch from New Chambers street on the north to Wall street on the south, from Pearl street on the east to Nassau on the west, distributing power in amounts ranging from two to eight horses, among fifty-two different patrons, the total being 215 horses. The power is used for:

1. Elevators and hoistways.
2. Machine shops, instrument makers and burnishers.
3. Printing and bookbinding.
4. Pumping, ventilating and fanning.
5. Jewelers and lapidaries.

It is a noteworthy fact that considerably more power is leased than is produced at the generating station, and this without the slightest interference or failure to respond to every draft upon it. This feature is a peculiarity of electric power, and is touched on above. The current generators are of 150 h. p. capacity.

The Boston distributory service was started experimentally in December, 1883, and was enlarged to its present capacity about six months later. A 50 h. p. Daft dynamo generator supplies current to a main circuit of No. .00 copper wire, 3,300 feet in length, and various branch circuits, 4,550 feet in all, of No. 4 copper wire—making a total of 15,700 feet, including the return wires. This is drawn upon by twenty consumers in amounts ranging from 1 to 11 h. p., and aggregating 90 h. p. The use is of much the same nature as in the New York service, but includes in addition the grinding of spices and the trituration of chemicals. The system covers an area measuring about 2,700 by 1,500 feet, or about one-sixth of a square mile.

The Worcester distributory service was organized in February, 1886, and at present is supplying 22 patrons with an aggregate of 90 horse-power in amounts ranging from 2 to 8 h. p. Its wires have an extent of about one mile. The service performed comprises incandescent lighting, and the running of printing, sewing and knitting machines, elevators, ventilators and machine tools.

The Rhode Island Power Company started a distributory service in Providence in September, 1884, which is doing a satisfactory and profitable business, but involves no features worthy of especial mention. The generator has a capacity of 10 h. p., the wire a length of about 1¼ miles, and the consumers, at last advices, three who use an amount ranging from 1 to 6 h. p. for purposes similar to those of the previously mentioned services.

Space forbids mention of many details of existing electrical railway and distributory power plants, and entirely precludes reference to such as are in process of construction. An important extension of the New York power installation is under way and five electric railways in various parts of the country are confided to the Daft Electric Light Company's hands.

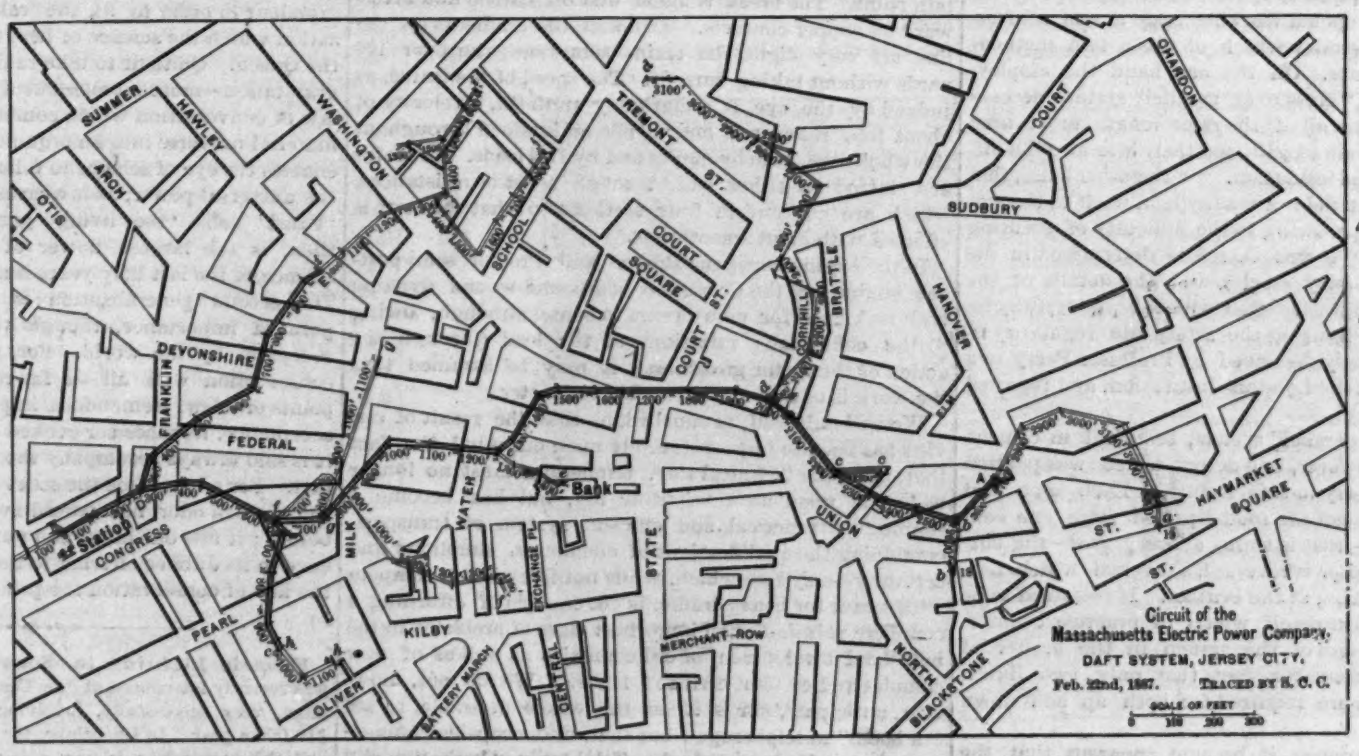


FIG. 2.—DISTRIBUTION OF MOTORS ON DAFT CIRCUITS IN BOSTON.

The Telephone Statistics of Europe.

We gave a few weeks ago some statistics, compiled by the American Bell Telephone Company, as to the development of the telephone business in this country. Through the courtesy of the Antwerp office of the International Bell Telephone Company, we are now able to present some very interesting figures as to telephonic progress in Europe. The statistics are the latest that have been compiled, and come down to the close of 1886.

The number of subscribers to the following telephone exchanges was:

Belgium.

Brussels	998	Le Louvière	22
Antwerp	1,043	Liége	438
Charleroi	216		
Ghent	419	Total	3,532
Verviers	396		

with an aggregate of about 6,900 kilometres of line wire constructed.

Holland.

Amsterdam	1,263	Arnheim	127
Rotterdam	330	Haarlem	69
The Hague	197	Dordrecht	143
Utrecht	129		
Groningen	65	Total	2,623

Aggregate of line wire about 3,700 kilometres.

Russia.

St. Petersburg	1,080	Odessa	525
Moscow	690	Lodz	209
Warsaw	533		
Riga	403	Total	3,440

Connected on 9,550 kilometres of wire.

Italy.

Milan	1,089	Leghorn	372
Genoa	950	Naples	873
Turin	614	Palermo	478
Venice	216	Catania	215
Rome	2,022	Messina	159
Florence	721		
Bologne	364	Total	8,073

Aggregate of about 12,500 kilometres of line wire.

The largest increase of subscribers was in Belgium, about 18 per cent., and in Russia, about 15 per cent., as compared with the figures of 1885. The other countries show less progress. The average increase of all the said towns which are worked by companies allied with the International Bell Telephone Company, Limited, of New York, is about 10 per cent., against 9 per cent. in 1885, and 9 per cent. in 1884.

In the above mentioned countries, there are besides a certain number of minor telephone exploitations. Thus we find in Belgium 7 small towns with telephone exchanges having a total of about 550 subscribers.

In Italy, there may be 12 such small towns with the telephone, about which no relisble data can be obtained.

In Russia, 6 other towns of more or less importance have telephone installations, whose number of subscribers may be put down as 600 in the aggregate, up to the end of 1886. The striking fact about these figures is that there are thus only 19,000 telephone subscribers in a population of 136,000,000, while in America we have 147,000 in only 60,000,000. Kansas City and its suburbs have practically as many subscribers as all Russia.

The Telpher Line at Glynde, England.*

The telpher line at Glynde has now been in operation for a period of over two years, and the time has certainly arrived when the question as to the success or non-success of this system of transport should receive a final answer. The question is admittedly one of no slight importance. If telpherage can be demonstrated to be both technically and commercially practicable under the conditions of everyday service, it is not too much to assert that "the resources of civilization" will have been appreciably widened, while the electrical industries will be materially benefited to an extent which no one can at present foresee.

But is the Glynde line a success? So little definite information having appeared in the public prints on the subject it is natural that remarks of an unfavorable character have not been altogether wanting. When, therefore, we received an invitation from the Telpherage Company to "come and see for yourselves what we are doing at Glynde," we did not hesitate—notwithstanding the torrid heat of the season—to undertake the expedition. Arriving at Glynde after two hours' stewing on the London, Brighton & South Coast Railway, we found the genial engineer of the Telpherage Company (Mr. C. S. E. Crakanthorp), who accompanied us upon our tour of inspection. That the telpher line is by no means in a state of inanition was soon apparent. Scarcely had we crossed the fence by the side of the railway when a gentle rumbling announced the approach of a telpher train. On it came at a perfectly uniform speed over the river, round by the bend at the end of the first field, and on to the loop which brings the skips over the railway trucks, into which their contents are tilted. To one who has not seen it before, the first sight of a telpher train presents a very singular appearance. The pecular cat-like way in which the skip in front climbs over the top of the poles and walks steadily over the inclines, while the wire rope sags beneath the weight of the train, is very striking. What is actually being done at Glynde may be summarized as follows: Three trains are running continuously, each consisting of ten skips, and making on the average about 15 journeys daily. Each train carries rather over one ton of clay, so that the total weight moved is about 270 tons per week. The engine plant and the capacity of the line itself are equal to a service of four trains, so that 360 tons per week could be carried with very little increase on the present working cost. That cost is at present $30 per week, a figure which enables the Telpherage Company to carry out their contract with the Sussex Portland Cement Company, of Newhaven, under remunerative conditions, even at the low contract rate of 15 cents per ton.

I incidentally alluded to the fact that the trains run upon wire ropes; it will probably be remembered that the original plans (or more strictly *one* of the original plans) of the inventors of the system, the late Professor Jenkin and Professors Ayrton and Perry) contemplated the use of steel rods stretching from span to span. Until experiment had actually been made upon a working scale it was confessedly difficult to determine which of these two methods would prove the better. On the one hand the employment of rods on the "cross over parallel" system necessitated the use of spans all of the same length, or at least not exceeding a certain length, and there was also the difficulty of jointing and insulation. On the other hand, that system of connection did not readily lend itself to the employment of wire rope, owing to the difficulty of securing it to the post-heads. It was therefore determined in the first instance to employ steel rods. The details of the construction of the line, together with the wonderfully ingenious devices for insuring the safety and regularity of the service, were fully described by Professor Perry in a lecture delivered at the London Institution, and reported at the time.

The "cross over parallel" system, beautiful in conception as it is, has, however, one defect, which was pointed out by Professor Perry in this lecture. Each time that the collecting wheels of the motor passed from one conductor to the other—that is to say at every post—the current through the motor is reversed, a reversal which necessarily entails sparking at the brushes. It remained to be seen how far this drawback would in practice counterbalance the advantages of the system in the matter of economy arising from the fact that only two (intercrossed) conductors are required for both up and down lines.

After some experience, it became apparent that the motors at first adopted were unsuited to this particular class of work under the then existing conditions, and it unfortunately happened that the gentleman by whom the motors were originally designed was unable at the time to give his personal attention to the matter. We think it right to mention this fact because we are anxious not to give an unnecessarily unfavorable impression as to the merits of this particular motor, which, as Mr. Crakanthorp was himself careful to point out to us, has scarcely been able under the circumstances to receive a fair trial.

At this junction, however, an Immisch motor was placed upon the line in parallel with one of the older type, and it at once became apparent that the former did the same work with exactly one-half the energy supplied—that is, one-half the number of ampères at the same volts. It is not, therefore, surprising that the Immisch motor has been finally adopted by the Telpherage Company. The type at present in use has a 4-inch armature, weighs 105 pounds, and develops 1 horse-power running at 1,700 revolutions.

Concurrently with the change of motors it was decided to make such alterations to the line itself as would allow a simple parallel system to be adopted, principally in order that steel wire ropes might be substituted for rods, which were found to have a very much shorter life than had been anticipated. This has been carried out with great success; the steel ropes are 2⅛ in. in circumference, and are anchored to cross-beams buried in the soil, with tightening screws for straining up when required. The alteration necessitated, however, the employment of a second wire on both up and down lines in order to convey the current. This wire, which also takes the form of a steel wire rope of 1¼ in. circumference, is insulated throughout its length. The current is taken off by a jockey pulley made in copper with wide flanges, and the wire upon which the train runs is earthed throughout, as also is the negative terminal of the dynamo. The system, in fact, has now reverted very nearly to that described in one of the earlier patents of Profs. Ayrton and Perry.

The conditions under which a motor running upon a telpher line is worked are necessarily such as to submit the apparatus to an extremely severe test. The protection which can be given against the weather is very slender at the best.

It is under such conditions that the Immisch motors at Glynde are now working with complete success. This satisfactory result has not, however, been attained without a good deal of painstaking attention to matters of detail both on the part of the Immisch Company and of Mr. Crakanthorp. The Immisch Company at one time sent one of their representatives (Mr. A. Snell), to stay for some time upon the spot in order to study the working conditions as completely as possible. The results now attained will be appreciated from the statement that the motors frequently run for a fortnight without even having their brushes readjusted. The commutators receive a touch of vaseline from the switch man at the end of every journey.

The average E. M. F. along the whole line is 170 volts, there being only a volt or two difference between the engine house and the extremities of the line. The total current taken by the three trains amounts to 20 ampères; but owing to the admirable action of the automatic circuit-closers governing the speed of the trains (a feature which is due to the late Prof. Fleeming Jenkin) it is comparatively seldom that the full current is taken for more than a very short interval. The variations of current between 8, 14 and 20 ampères, as shown in the engine-room ammeter, follow one another in rapid succession. The loss by leakage is two ampères. The governors, it will perhaps be remembered, act by centrifugal force, entirely cutting off the current when the speed of the armature exceeds a certain point. The break is made first on carbon and afterward on copper contacts. Although the gradients on the line are very slight, the trains sometimes run over 100 yards without taking current. The speed of the trains, as judged by the eye, is remarkably uniform, a velocity of about four miles per hour being maintained throughout the whole line, both by empty and by full loads. The trains are started at either end, through a set of resistances, which are cut out in four sections, so that the start is effected with great smoothness.

In the engine house the Ruston and Proctor semi-portable engine and the Crompton compound-wound dynamo both look good for many years to come, although, owing to the continuous variations of the load (through the action of the motor governors), it may be assumed that the work is of a somewhat trying character.

We will only add, in conclusion, that the result of our visit has been to impress forcibly upon our mind the fact that, upon the technical side, telpherage must no longer be looked upon as a scientific toy, but has become a thoroughly practical and efficient system of transport, combining the qualifications of cheapness, simplicity and certainty—a system which, while not intended to compete with steam for heavy traffic, is yet capable of affording a complete solution of an important class of problems in the industrial development of old countries as well as of new colonies and of semi-civilized lands. We do not, however, anticipate, nor is it on the whole desirable, to see "a boom" in telpherage; but that, under capable management, the business of the Telpherage Company will steadily grow into industrial importance we regard as a certainty.

*London *Electrician*, June 17.

Lima, O.—The Van Depoele electric road has gone into operation at Lima, O., with four cars, very successfully. On July 4 the cars averaged over $100 apiece in fares.

The Escurial, Spain.—An arc plant has now been put in the celebrated palace and monastery known as the Escurial. In the chapel there are eight arcs of 4,000 candle power each and eight more have been put on top of the tallest tower.

Hastings, England.—The Hastings Electric Light Company, it is interesting to know, has just issued its fifth annual report—a thing few other lighting companies in England have succeeded in doing. The company's business shows a steady growth. It now has on three circuits 30 arcs and 704 incandescents. The company proposes to extend its business by raising $25,000 on debentures.

Tyndall and Faraday.

At the banquet given to Prof. Tyndall recently in London, on the occasion of his retirement from active work at the Royal Institution, that distinguished physicist, speaking of Faraday, said:

"In 1850, during a flying visit from Germany to England, I stood for the first time in the bright presence of Faraday. In February, 1853, I gave my first Friday evening lecture in the Royal Institution; and three months afterwards, on the motion of Faraday, the old Chair of Natural Philosophy, which had been filled at the beginning of the century by Thomas Young, was restored, and to it I was elected. It causes me genuine pleasure to think that I shall be succeeded in that chair by so true and so eminent a man of science as Lord Rayleigh. It is not my intention to overburden you with egotism to-night; but, casting an earnest glance back upon the past, a few words seem due from me to the memory of one or two of the group of good men, no longer with us, with whom I was so intimately associated. Regarding Faraday, I will confine myself to stating that years have not altered my estimate of the beauty and the nobleness of his character. He was the prince of experimental philosophers; but he was more than this—in every fibre of his mind he was a gentleman. I might point to the industries which affiliate themselves with Faraday's discovery of benzol, and with his discovery of the laws of electrolysis. But I need not go further than the fact that in this our day a noble and powerful profession has been called into existence by his discovery of magneto-electricity. The electric lamps which mildly illuminate our rooms, the foci which flood with light of solar brilliancy our railway stations and public halls, can all be traced back to an ancestral spark so small as to be barely visible. With impatient ardor Faraday refused to pause in his quest of principles to intensify his spark. That work he deliberately left to others, confidently predicting that it would be accomplished. And prompted by motives both natural and laudable, but which had never the slightest influence on Faraday, others have developed his spark into the splendors which now shine in our midst. It would be a handsome Jubilee present, if it were a possible one, to roll up the career of Faraday into portable form, and to offer it to the Queen as the achievement of one of her Majesty's most devoted subjects during her own reign. Faraday's series of great discoveries, however, began in 1831, which throws his work five or six years too far back. During the rest of his fruitful life he was a loyal son of the Victorian epoch. But, passing beyond the limitations of the individual, what is science as a whole able to offer on the golden wedding of the Queen with her people? A present of the principle of gravitation—a handing over to Her Majesty of the bit and bridle whereby the compelling intellect of Newton brought the solar system under the yoke of physical laws—would surely be a handsome offering. I mention this case of known and conspicuous grandeur in order to fix the value of another generalization which the science of her reign can proudly offer to the Queen. Quite fit to take rank with the principle of gravitation—more momentous if that be possible—is that law of conversation which combines the energies of the material universe into an organic whole, that law which enables the eye of science to follow the flying shuttles of the universal power, as it weaves what the Earth Spirit in 'Faust' calls 'the living garment of God.' This, then, is the largest flower of the garland which the science of the last fifty years is able to offer to the Queen. The second generalization is like unto the first in point of importance, though very unlike as regards its reception by the world. For, whereas the principle of conservation with all its far-reaching and, from some points of view, tremendous implications, slid quietly into acceptance, its successor evoked the thunder peals which it is said always accompany the marriage of thought and fact. For a long time the scent of danger was in the air. But the evil odor has passed away; the air is fresher than before; it fills our lungs and purifies our blood; and science in its Jubilee offering to the Queen is able to add to the law of conservation the principles of evolution."

Electric Lighting in Scandinavia.—Electric lighting was recently introduced at the Central Railway Station, Christiana, very successfully, involving a loss to the gas works of $10,000 a year. In Christiana, the gas works are city property, and the corporation is now going in for an electric light plant of its own. The steamers running along the west coast of Norway have been fitted up with Edison installations. In Stockholm the leading theatre is now lighted by electricity, and the city of Gothenberg, Sweden, is to have its streets lit by electricity.

Overhead Service.—A new company is being organized in Pittsburgh for the purpose of holding and selling patent rights for electric railway purposes. It is to be called the Overhead Conductor Electric Railway Company, and has a capital stock of $300,000. Among those interested in it are George Westinghouse, Jr., John Caldwell, H. H. Westinghouse, Frank L. Pope and Thomas B. Kerr. The company's conductors, instead of being under ground, are to be overhead like telegraph wires. The Observatory Hill electric road and the Mount Oliver electric road will, it is said, operate the patents of this company. It is claimed that this method of conductors is a signal advantage over the underground method, as it preserves them much longer.—*Iron Age.*

The Edison Electric Light Company.

To this company the public is indebted for the original development and introduction of the incandescent light system. It was organized for the purchasing of Mr. Edison's inventions, developing the industry commercially, and placing the new light in the hands of the people of North and South America. The gentlemen who originally joined themselves with Mr. Edison in the development of his light continue that association in the promotion of the industry commercially.

The Edison Electric Light Company owns and controls upwards of 400 fundamental and auxiliary patents of Mr. Edison and others, requisite to the creation of a comprehensive system of electric lighting, heat and power. The function of this, the parent company, is simply to own and protect these patents, and to grant rights for their use throughout the territory controlled by them. Subordinate organizations have been created by it for the purpose of introducing the light to the public in many practical forms. The Edison Electric Light company early determined to supply their light to the public in precisely the same manner as gas is furnished, having proven to their satisfaction the feasibility of so doing by an exhaustive experiment made within Mr. Edison's grounds at Menlo Park, distributing in this experiment upward of 1,000 lights over an area of a mile square. In the carrying out of this determination there was organized in the City of New York the Edison Electric Illuminating Company. This company undertook to supply and has for nearly five years been supplying light to all who may elect to use it within the area of their operations, namely, from Broadway to the East River, and from Wall street to Printing House square, thus including a district of more than a square mile. In consequence of the unexpected growth of this system, an annex or auxiliary station has been established, feeding into the same mains at a point of large consumption. The result is a perfect demonstration of the practicability, from every point of view, of house to house lighting where electricity is generated at a central station, distributed through conductors laid under ground, and delivered to the consumer through a meter and used by him at will and with greater simplicity and more ready command than gas; as well as a demonstration also of the fact that capital may be profitably embarked in this enterprise in competition with gas. This station was started in the month of September, 1882. Notwithstanding the fact that it was to a certain extent experimental, and that great practical difficulties were encountered in the matter of laying the underground conductors, it has continued in operation without cessation day or night up to the present time. Consequent upon the success of this first effort, numerous like organizations have been effected throughout various parts of the United States, Europe, South America, etc., and now three new large stations each of 30,000 light capacity are to be built in the residential part of New York City.

A view of the interior of one of these great stations will be found among the illustrations shown. Many improvements have been effected since the first effort, and to-day it is as economical to distribute over an area of several square miles as over one at the time of the inception of the first station in New York. In illustration of this, it may be noted that many cities and towns have adopted this system of lighting with great success, as, for instance, Lawrence, Mass.; Detroit, Mich.; St. Paul, Minn.; Boston, Mass.; Harrisburg, Pa.; Rochester, N. Y.; New Orleans, La., and a large number of others, aggregating about one hundred, operating over 300,000 lamps. There are also in process of construction the three mammoth stations in New York, and others in Brooklyn, Chicago and Boston aggregating over 200,000 additional lamps.

In none of the residences, stores or other buildings supplied with the light from these stations is there any other apparatus or device than the ornamental fixtures, the wires necessary to connect such fixtures with the street conductors, and the meter for the measurement of the light. It has thus been demonstrated that this new light, which lends itself in such a wondrous way to decorative and useful purposes, and which, from the fact that it contributes no noxious gases to the atmosphere of our homes, nor takes from that atmosphere any of its vital properties, is so readily controlled, always at command and absolutely safe, and is, in short, the perfection of artificial illumination, is attainable to all who wish to use it.

It will be readily understood, however, that where buildings, such, for instance, as mills, factories, asylums churches, theatres, hotels, country residences, steamboats or other structures are, by reason of their isolated character, or by reason of the impatience of their owners, obliged to secure the electric light in advance of the establishment of these great enterprises, some means must be perfected for meeting their wants. For this purpose Mr. Edison devised a complete miniature system of generation, regulation and distribution to be placed upon the premises to be lighted and to be the property of the owner thereof. The demand for this class of electric light plant was early made apparent, and in order to meet it there was organized the Edison Company for Isolated Lighting. This company, with a capital of $1,000,000, operated successfully from November, 1881, until 1886, when its business was assumed by its successor, the Edison United Manufacturing Company. Up to the present time an aggregate of over 900 plants and 300,000 lamps have been installed. These plants are of a capacity ranging from 25 to 5,000 lights each, and have been, almost without exception, purchased by the users and operated by them without supervision or other assistance from the company. The perfection of the Edison methods cannot better be shown than by the statement, that in case a company or private purchaser may desire to test experimentally the character, quality and economy of this light, and for that purpose installs such machinery as will do but a mere fraction of the total lighting anticipated, that machinery may be added to from time to time until the total output of the plant attains any desired proportion without detracting from the efficiency of the initial plant, and yet obtaining as perfect an installation as if put in originally as a whole. The operations of this company at the Philadelphia Electrical Exposition, as also the exhibits made by them at the similar expositions of Paris, London, Vienna, Turin, Munich and also the contract lighting effected by them in the great industrial expositions of Louisville, 1883; Louisville, 1884; Cincinnati, 1883; and the still vaster undertaking of lighting the World's Exposition at New Orleans, give a fair but still inadequate idea of the scope and character of this company's achievements. Among their numerous triumphs may be mentioned their undertakings in marine lighting. The great cost, dangerous character and general nuisance of other forms of artificial lighting are more prominently brought to notice within the confined space of a ship than elsewhere, and for this reason the Edison electric light early made its entry into this class of work. The first steamer in the world to practically apply Mr. Edison's inventions was the steamer "Columbia," of the Oregon Railway & Navigation Company, which was entirely fitted up and lighted by him in 1879. This was the first such commercial plant ever installed, and is still in use. The example thus set has been followed with such marvelous rapidity that to-day it is exceptional to see a first-class war, passenger, pleasure or other vessel illuminated by any other light. Among the numerous vessels thus equipped may be mentioned the magnificent steamer "Pilgrim," of the Fall River line, in which there are employed 960 lamps, being the largest electric light installation afloat. The other vessels of this line, many interior river boats, several Government vessels, the troop and war ships of the British Government, the famous "Dandolo" of the Italian Government, the "Richelieu" and others of the French navy, the "Livadia" of the Russian Government, and others of this class, as well, also, as many of the modern and luxurious private yachts, as for instance, those of Mr. James Gordon Bennett, Jay Gould, W. W. Astor, Elbridge T. Gerry, and many of European ownership, have adopted Edison's system of illumination.

The wonderful ease with which this light may be controlled, especially characterizes it as the light par excellence for producing scenic effects upon the stage, and further, its safety and comfort particularly adapting it to the requirements of large assemblages, render it absolutely the only light for theatres, hotels, churches and wherever people congregate in large numbers.

It must necessarily strike the reader that in the development of so great an industry the manufacturing branches become large and important factors. That this is true cannot be better shown than by a brief review of the establishments which have grown up in connection with the Edison electric light interests. There are many of these factories throughout the world, but we will confine our description to those in the United States.

The Edison Lamp Company, of Harrison, N. J., employs over 500 hands in the manufacture simply of the lamp itself, no other work being done. Its capacity at the present time is 5,000 lamps per day, which may, without other addition than an increase of the number of employés, be augmented to 25,000 per day. This was the first factory for the manufacture of incandescent lamps, and as it was created under the direct personal supervision of Mr. Edison himself, the lamp has attained a wonderful degree of simplicity, perfection and economy. So much is this the case that, notwithstanding the fact that in Europe there are other large Edison factories for the manufacture of lamps, employing the best talent attainable, it annually exports to Europe alone a half million of lamps. An interesting fact may be here noted concerning the manufacture of the carbon filament. Mr. Edison reached the conclusion that it was impossible for man to put together a fibre by artificial means as perfect for this purpose as nature has herself provided. He thereupon instituted a most thorough search for a collection of the multitudinous fibres to be found upon the face of the earth, the result being that a certain species of bamboo taken at a given stage of its growth produced the best results. It was further believed that this particular bamboo might be so cultivated as to be improved. He thereupon sent his agent to Japan, the native clime of this species,

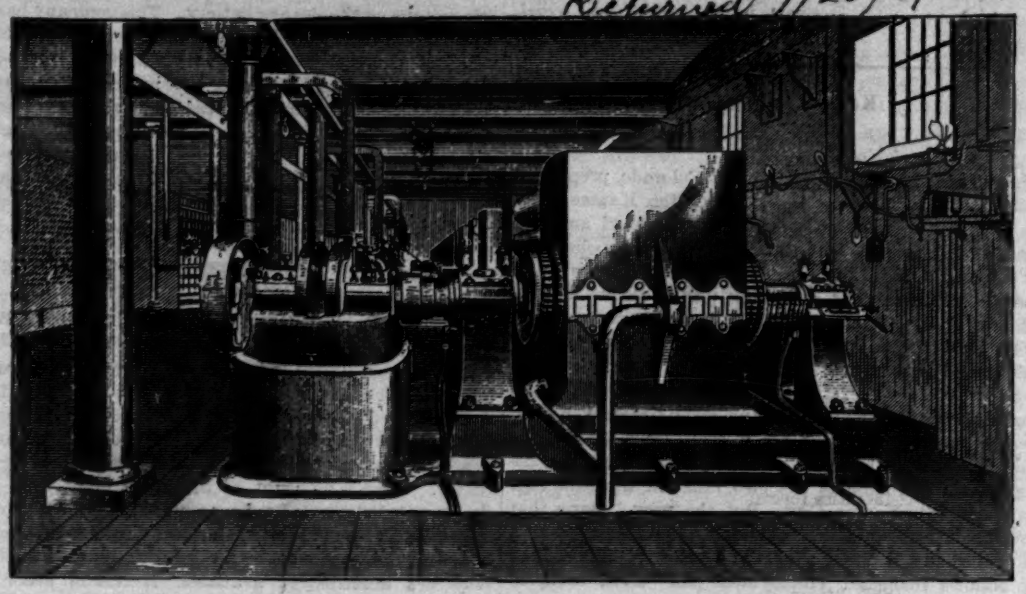


FIG. 1.—EDISON STATION, MILAN, ITALY.

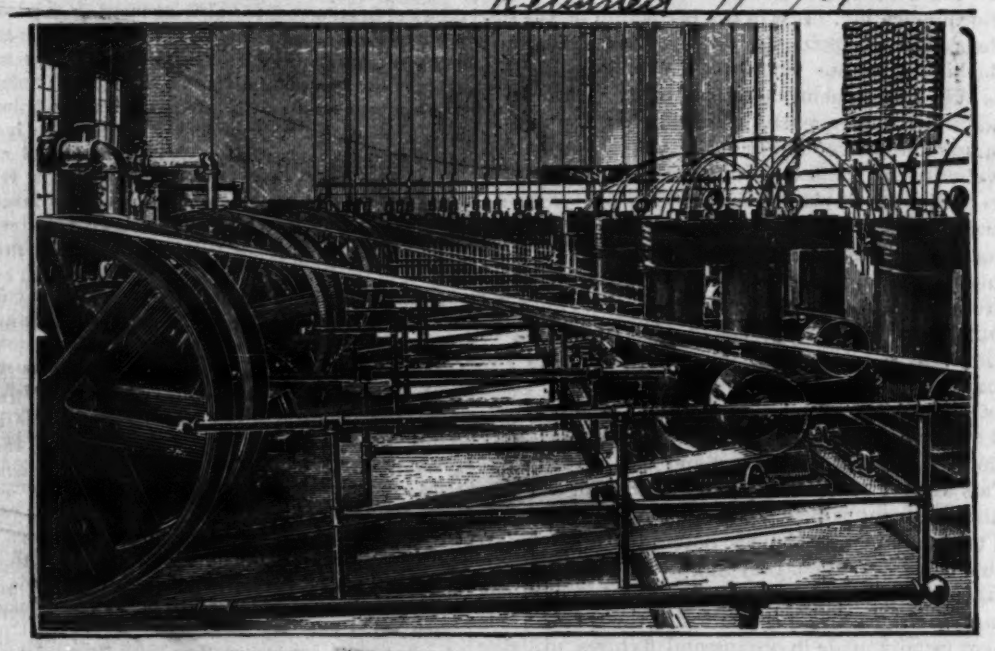


FIG. 2.—EDISON STATION, HARRISBURG, PA.

and effected arrangements there for the continuous shipment of large quantities of this bamboo to his several factories at regular periods each year.

At the Edison Machine Works, Schenectady, N. Y., are manufactured the dynamo machines which generate the electric energy to supply the lamps. The corporation at times employs as many as 800 to 1,000 men. The machines turned out from this establishment are likewise the product of Mr. Edison's own personal supervision, and in their efficiency and general character are not surpassed by any other electric generators, as has been shown by numerous scientific tests, and as is also shown by the fact that they are to-day exported to all parts of the world. From Finland to the Cape of Good Hope, and from New Zealand to China, installations have been made with them. It may be of interest here to note that the first Edison dynamo ever manufactured for other than experimental use was placed at the disposal of the officers of the ill-fated Arctic steamer, the "Jeannette," and with that vessel now lies at the bottom of the Arctic sea. The exhibition at Philadelphia showed the first colossal dynamo ever completed and practically operated.

The same factory affords facilities for the manufacture of shafting, pulleys and the Edison system of underground conductors. Mr. Edison having early determined to inaugurate his electric light on a scale commensurate with the demand, and, in fact to duplicate the gas system of supply, it appeared to him that the conductors for distributing such vast quantities of electrical energy over so large an area, and in a manner to supply each and every house in the city, could not, in the largest installations, be placed on poles or otherwise above ground, and must, therefore, go underneath with the gas and water mains. He was not daunted by the frequently expressed opinion of various scientific authorities to the effect that an underground system of electrical distribution was a practical impossibility. On the contrary, his experiments at Menlo Park demonstrated to him that it was entirely feasible. The development of these experiments was rapid and complete, and the efficient and reliable operation of the twenty-eight miles of these underground conductors in the City of New York for a period of five years entirely sustains the practical character of his invention. These works have manufactured hundreds of miles of these tubes for electric light currents, and have applied the same principle to telephonic, telegraphic and other electric purposes — among other instances manufacturing tubes containing 250 wires each for telephonic purposes in the City of New York. The peculiarity of the Edison system of underground conductors consists in filling the tube entirely with a compound which will not absorb moisture, thus permanently preserving the insulation of the conductors by preventing condensation within the tube.

Bergmann & Company, New York, employ over 500 hands. Their branch of the industry is to manufacture all the detail of the Edison system of electric lighting pertaining to the regulation, safety, control, measurement and interior application. It is in the perfection of the detail of the system of electric lighting that Mr .Edison has earned the highest praise wherever it has been brought to notice. No requirement, however trifling, has been overlooked. In consequence, the switches, by means of which any number of lamps from one upward may be individually or collectively controlled, the socket for the reception of the lamp, the devices for insuring safety and reliability of the light, the apparatus for indicating variations of electric pressure, devices for regulating such pressure, ornamental and artistic fixtures for interior decoration, and the thousand and one minor supplies for the new industry of Edison electric light fittings, all bear evidence of having received the same thorough attention as has been given to the main factors of the system. Among the many articles manufactured by this company deserving of special notice may be mentioned their combination gas and electric light fixture. This was invented and is manufactured for the purpose of filling a want which soon made itself apparent, namely, to supply new residences, hotels and other buildings with a fixture in which they might use gas until such time as the electric light was available, and then without displacing the fixture or otherwise losing the considerable investment usually made in ornamental fixtures, utilizing them for the electric light.

From the foregoing résumé of the Edison electric light manufacturing and other industrial enterprises it will be seen that Mr. Edison's early forecast of the future of his great invention was not without a solid foundation. His prophecies, even as magnified by the romancing newspaper man, can only be said to have been premature in point of the time requisite to develop so great an industry. The poetic fancy that electricity was to light the world in a day will be seen to have been only amiss in the interpretation of what constitutes the period of time. The vast amount or labor, capital and time that have been employed in creating the present system of gas lighting, as in use throughout the world, must of necessity be to some extent repeated in the duplication of it by a system of electric lighting.

The first rosy anticipations of untold profits which the public are wont to expect in the infancy of every new enterprise had to be destroyed. The practical character of the industry had then to be shown. Its economy and power to compete on a purely commercial basis with other forms of artificial lighting had then to be demonstrated, all of which of necessity consumed a great deal of time. But now that this work has been done, we may reasonably expect that if the exhibit which we have made of the Edison electric light enterprise in this number were to be remade a few years hence, the figures which we to-day present, and which seem of themselves so vast, would appear insignificant by comparison.

In one direction alone, that of the sale of current for the transmission of power by electric motors, many stations are now finding a profitable field for utilizing their capabilities during the hours of daylight, when the consumption in lamps is usually least. The first district of Boston has taken the lead in this new direction, with most gratifying results.

Kansas City.

BY. E. R. WEEKS.

Some fifty years ago, Governor Gilpin, of Colorado, prophesied that the bluffs and lowlands at the mouth of the Kansas River would be the site of a great city lying part in Missouri and part in Kansas, and suggested that it be named Centropolis. His prophesy has been fulfilled, and the rising generation will see what a few decades since was a trading post in the wilderness, become America's largest inland city. It would have been well to follow the Governor's suggestion as to name, as "Kansas City" is misleading, and not sufficiently cosmopolitan.

To the casual eye, the site, with its almost perpendicular bluffs separating the broad lowlands from the seven times seven hills, must have appeared quite unfit for a commercial centre. In early times, Westport Landing, with its bridle path threading the ravines, gave small promise of the two hundred thousand that 1887 was to realize in Kansas City. But the very features that seemed to offer insurmountable obstacles to the formation of a city have proved an advantage; for the leveling of hills and the filling of hollows furnished employment for labor, occupied capital, and tided the city over the period before her factories were built and her commercial importance established; before railroads began to fully realize that she is their natural centre.

In addition to the advantages of navigation, the junction of two large rivers affords the best facilities for railroad transportation, furnishing, as it does, the most desirable grade to the east, north and west, thus giving easy access to almost boundless regions of fertile and fruitful country. The first railroad was completed to Kansas City in 1866. In 1887, fifteen carry to and from her boundaries products of every kind.

The site of the city offers unsurpassed advantages for manufactories and for railroad and stock yards, as on two sides lie broad areas of bottom lands, easily reached by both rail and water. The varied timber and mineral resources of Missouri and the neighboring states yield a never-failing supply of crude material for manufacturing purposes. Although Kansas City has about three hundred factories, their interests have not as yet assumed the importance which the natural advantages of the place would warrant, but such enterprises are being established almost daily, and the communications constantly pouring into the Manufacturers' Bureau show that the city's growth in this direction is assured.

With all her advantages of site, Kansas City enjoys other good things of equal permanence; lying midway between our extreme north and south, her climate allows such rotation and variety of crops as secures for the surrounding country immunity from exhaustion of soil. Almost all agricultural products important to commerce are found in abundance in her tributary regions. Her mineral resources are inexhaustible. The boundless plains to the west send to her doors countless droves of cattle, and she now ranks as the second meat packing city of the world. Her grain and commission business has assumed large proportions, and from a landing for goods to freight ox trains for Colorado and New Mexico, she has grown to one of the greatest jobbing centres of the West.

In all public improvements which add to the culture, convenience or comfort of a people, she has not been a laggard. Her schools, with their several hundred teachers, rank with the best in the land. Their graduates have won high honors in the first Eastern colleges. Her society is cosmopolitan, being made up of people from all parts of the world, especially from the eastern states. Representatives of any class need not be without congenial companions. The city has embryo literary and art foundations, which demonstrate her growing permanence of population, and prove clearly that she has passed the immature stage in her growth.

Streets are being rapidly paved, and the fall of '87 will see completed over twenty-five miles of pavement. Fifteen street railroads are now in operation, or in process of construction,—seven cable lines, six horse lines, one electric line, and the only elevated road outside of New York City. An extension to the elevated road, running three blocks underground, will be completed in the fall. Numerous dummy lines are projected, and, when built, will penetrate many miles into the adjoining country.

The National Water-Works Company, using the Holly system, furnishes the water supply, and property is well protected by efficient fire and police departments, assisted by several lighting companies.

A good grade of gas is supplied by the Kansas City Gas Light and Coke Company at a moderate rate. Natural gas been found in such quantities that companies have been organized for its general distribution. In the spring of 1886, G. F. Winter, F. Howard, J.J. Everingham, James Scammon and others formed the Sperry Associate Electric Light Company which, at present, has one hundred and nine arc lamps in service, and is putting in machinery to double the capacity of its plant.

The Edison Electric Light and Power Company, recently organized with a capital of $100,000, numbers among its stockholders such men as G. H. Nettleton, E. H. Allen, C. F. Morse, A. W Armour, John Doggett, C. L. Dunham, R. H. Keith, C. S. Wheeler and S. M. Jarvis, and has contracted for 4,000 incandescent lights to be installed within eight months. In addition to light for stores and residences, this company will also furnish electric power.

The Kansas City Electric Light Company is the pioneer in this field, and is one of the oldest electric lighting companies in America, having been organized in 1881. Some of its stockholders are Wm. B. Grimes, J. W. Phillips, J. S. Chick, W. W. Kendall, J. H. North, O. H. Dean, F. K. Hoover, D. S. Orrison, T. S. Case, C. E. Barnhart, Warren Watson and H. F. Devoll. It was the first sub-company to adopt the Thomson-Houston system of arc lighting, and was the first to serve the Sawyer-Man incandescent light from a central station. Its present station is a substantial two-story brick building, 50 × 110 feet, containing 600 horse-power—a capacity of 720 two thousand candle-power arc, or 5,400 sixteen candle-power incandescent lamps. It has in service 450 arc and 500 incandescent lights; and, having recently doubled its capital stock, is arranging for a large increase in both departments, as well as for the extensive introduction of the electric motor and the storage battery. This company has purchased a lot 56 × 94 feet on Wall street, in the centre of the business section, and proposes to erect thereon a five-story fire-proof brick building, to contain 1,800 horse-power, enough to operate 2,160 standard arc or 16,200 sixteen candle-power incandescent lamps. From this station will be furnished power for electric motors ranging from one-eighth to twenty or more horse-power. The power department will be something new in Kansas City, and will supply a long felt need.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
CHICAGO, July 12, 1887.

The following taken from a daily paper is of interest in showing the favor into which the electric light has grown in this city: Action should be taken before the City Council adjourns for the summer vacation on the report of the Committee on Fire and Water recommending the lighting of the city bridges by electricity. There is no doubt of the practicability and economy of the proposed plan. It has been approved by the Mayor, the Commissioner of Public Works, and the City Electrician. The estimates for the work have been carefully made and the funds necessary are immediately available. Action in accordance with the recomendation made will not be in the nature of an experiment except as far as it refers to the extension of electric lighting to the whole city. The plant for the bridges may yet be made the nucleus of a comprehensive scheme of city illumination. The greed of the gas monopolists and their extortionate combinations are likely to compel the municipal government to undertake the work of city lighting. Any step in that direction now will be of great advantage hereafter. The partial plan now proposed by the Council committee will be carried on under the supervision of the Commissioner of Public Works. This insures economy, expedition and satisfactory performance. Concerning the great advantages of electric lights over gas lamps for bridges, we have abundant evidence at Lake and Rush street bridges. The greater illumination will not only be a source of pleasure and convenience to the public—it will be a source of security and safety as well. It will facilitate the crossing of the bridges by fire engines, and it will powerfully aid in the night navigation of the river. There have been few recommendations made to the City Council for years that have been so generally acceptable or so likely to prove of permanent and increasing benefit as this one promises to be. The Council should take up the order as recommended at its next meeting or make it a special order for an early date.

In connection with the above, I am pleased to report the passage of the ordinance by the City Council for lighting a portion of the Chicago River, the Council appropriating fifteen thousand dollars for that purpose. The total estimated expense for installing this system is forty-seven thousand dollars.

The ordinance is as follows:

"That the Commissioner of Public Works is hereby authorized and empowered to contract for the construction and maintenance of an electric light system within the limits of the city of Chicago, along and upon the Chicago River and its branches and the bridges, viaducts and ends of streets contiguous thereto, between Halstead street on the South Branch and Halstead street on the North Branch and from those points to the mouth of the river. The Commissioner of Public Works shall designate the route or routes, streets, bridges, tunnels, and viaducts, in and through which said system shall be extended, and shall have full power to prescribe and enforce all lawful conditions and regulations as to the erection and maintenance thereof."

Mr. Chas. Desmond has resigned his position as engineer in charge of the Palmer House plant.

A new electric clock invented by a Mr. Chas. Gifford has been on exhibition the past week at the Briggs House.

Concerning electric motors, I clip the following from a Lima, O., dispatch:

"An old-fashioned Fourth of July celebration took place in this city to-day. A feature of the occasion was the formal opening of the Lima Electric Street Railway, which is equipped with the Van Depoele system of electric motors and generators, manufactured in Chicago. It was the event of the day, and thousands of people cheered the cars in their electrical flight. They were loaded to suffocation all day long and way into the small hours of the morning. Not a single delay or stop occurred, and the crowded cars seemed to climb grades as easily as they descended. The system is as perfect as mechanism and ingenuity can make it, and our citizens are wild with delight at the exhibition of the powers of subtle electric force. The road is four miles long, and five cars are in operation. The use of horses to propel street cars is a thing of the past in Lima."

BUSINESS NOTICES.

The Kansas City Electric Light Company.—Should information of any kind be required as to the various systems and appliances described in this issue, it can be obtained from the Kansas City Electric Light Company, Mr. E. R. Weeks, Manager. Address Eighth and Santa Fe streets, Kansas City.